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Amplexing *Mixophyes balbus*. See paper on page 30.

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HERPETOLOGICAL NOTES

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A RELIABLE SIZE RECORD FOR THE SCRUB PYTHON *MORELIA AMETHISTINA* (SERPENTES: PYTHONIDAE) IN NORTH EAST QUEENSLAND.

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ABSTRACT

A wild caught adult female *Morelia amethistina* was recently examined and found to be 4900 mm SVL (snout to vent length) with a total length of 5651 mm (18 feet 7 inches). Mass was 24 kg. This is the largest snake ever reliably recorded in Australia and in the absence of verifiable data to the contrary, the authors suggest these dimensions represent the maximum size attained by Australian *M. amethistina*.

OVERVIEW

Morelia amethistina is often described as Australia's largest snake, however after more than 200 years of European herpetological study, the maximum size (length/mass) attained by this taxon has not been determined with any certainty.

Scattered throughout the literature are anecdotal accounts of total lengths in excess of 5000 mm (Table 1). Rarely are such lengths explicitly stated as originating from direct measurement or how measurements were taken and none can be verified. The authors are not aware of any reliable measurements in excess of 5000 mm.

Worrell (1954) gives a second hand account of a 8500mm total length, human killed specimen measured by Louis Robichaux at Greenhill, Cairns. Four years later, this same snake reappeared in the literature at 7600mm (Worrell, 1958). Five years later this snake entered the literature again at the original length of 8500mm, (Worrell, 1963) and this figure has been repeated by numerous authors, apparently without critical appraisal. It has been suggested that the 7600mm length was of the entire carcass and the 8500mm length, of the skin after removal from the body (McWhirter, 1984). No matter how carefully the skins of large pythons are removed, they can stretch by as much as 3000 mm (Murphy and Henderson, 1997).

The other field measurement of an outsize *M. amethistina* is provided by Dean (1954). He claims to have measured (with a surveyors tape) a 7225 mm total length specimen in the Barron Falls area of north Queensland. However, this record cannot be accepted as the snake had been dead for 48 hours "draped over the ridge pole of a vacant tent site", was decomposing and had been dragged from the point where it was killed over "very rough terrain". Hanging dead for 48 hours in the tropics could have resulted in considerable stretching of the carcass.

The extreme lengths reported by Worrell (1954, 1958) and Dean (1954) are open to question and cannot be verified. Greer (1997), suggests such lengths fall well outside the fairly tight relationship between maximum total length, and both the number of mid-body scale rows and the number of ventral scales. This analysis gives a maximum total length for *M. amethistina* of 5050 mm. Table 1 tends to support this analysis. If Dean (1954) is discounted, there are no first hand accounts in the literature of *M. amethistina* exceeding 5500 mm. Captive records also appear to support this analysis with Barker and Barker (1994) reporting that the largest Australian specimens in North American collections do not exceed 5000 mm.

Weight data for large, field caught *M. amethistina* are almost completely absent. Anonymous (1966) reports a 5050 mm total length specimen from Cairns with a mass of 25.9 kg.

Table 1. Literature records for lengths of large free ranging *Morelia amethistina*. **1 = actual measurement claimed or strongly implied.**
2 = snake actually seen by author.
3= author examined photograph of snake.

Source	**Total length (mm)**	**Total length (feet)**
Anonymous (1937)	5500-7000	18-22
Anonymous (1966)	5050[1,2]	16.7
Anonymous (1979)	4880[2]	16
Barrett (1950)	5500[2]	18
	7000[3]	22
Dean (1954)	7225[1,2]	23.8
Fearn (1998)	5500[1,2]	18
Frauca (1973)	5500[1,2]	18
Frith & Frith (1991)	5180[1,2]	17
Kinghorn (1956)	6400	21
McPhee (1966)	7010	23
Parker (1982)	5500-6000[2]	18-19.8
Skardon (1938)	5500[1,2]	18
Thompson (1949)	7010	23
Williams (1966)	4880[1,2]	16
	6620[1,3]	21.9
Worrell (1951)	6100	20
Worrell (1954)	8500[1]	28
Worrell (1958)	7600[1]	25
Worrell (1963)	5180[1,2]	17
	8500[1]	28

Weights for large captive specimens are better known. Barker and Barker (1994) record 22 kg for a 9 year old captive hatched female, 4900 mm in total length and 18 kg for a sibling male, 4500 mm in total length. The authors have examined a 13 year old captive hatched female approximately 4200 mm in total length with a mass of 21 kg and another female, 4004 mm, in total length (aged 2 years 8 months) with a mass of 13.1 kg.

THE SIZE RECORD

On the 23/10/99 the authors collected the first reliable data from a maximal sized free ranging *M. amethistina* (Figs. 1 & 2). Table 2 lists the dimensions of this snake.

The snake was removed (at the owners request) from a residential property at Veivers Road, Palm Cove, Cairns by staff of the Wild World Fauna Park. The snake was attempting to gain access to the interior of the house via verandah rafters when discovered.

Snout to vent length (SVL) was determined by inducing the snake to relax, momentarily, by tiring it. The anterior was secured at the end of a tape measure by one of the authors while the other author pulled on the snakes posterior, just forward of the vent, until the body was relaxed along the tape. This procedure is outlined by Fitch (1987) and while no method of measuring live snakes is 100% accurate, in the authors experience it is the most reliable method for measuring live snakes under field conditions.

Girth was determined with a flexible fibreglass dress makers tape wrapped around the snakes mid-body. Head dimensions were determined with Vernier calipers.

Mass was determined by placing the snake in a 1 kg bag and suspending it off 100 kg spring balance scales (accuracy + or - 1 kg).

Sex was determined with a commercially produced sexing probe. The measure of the penetration of the probe in both sides of the tail base of this specimen was 9 subcaudal scales. Barker and Barker (1994) state that probe depths for females do not exceed ten subcaudals.

Shortly after data collection the snake was released in the Palm Cove area.

CONCLUSION

The authors believe this is the largest snake ever reliably weighed and measured in Australia and suggest, in the absence of verifiable data to the contrary, that these dimensions represent the maximum size attained by Australian specimens of *M. amethistina*.

Figure 1: The Scrub python after removal from the house

Figure 2: The head of the Scrub python

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Our sincere thanks to Michael O'Brien, Robert Hervey and Paul Massey of Wild World Fauna Park, Palm Cove, Cairns for allowing access to the snake and assisting with data collection.

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Both authors wish to express their undying gratitude to Gavin "chucky" Huddleston of Cairns for loyalty and support above and beyond the call of duty.

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Table 2. Measurements (mm) and mass (kg) of maximal sized female *Morelia amethistina* from Palm Cove, Cairns, north east Queensland.

Snout to vent length (SVL)	4900
Tail length	751
Total length	5651
Mid-body girth	360
Head length (along the lower jaw, from the tip of the snout to the posterior edge of the quadratearticular projection)	120
Head width (between eyes)	45
(at base of skull)	70
Head depth (from top of head above eyes to underside of lower jaw)	44
Mass	24

A PRELIMINARY STUDY OF HABITAT USE IN THE SKINK *OLIGOSOMA NIGRIPLANTARE NIGRIPLANTARE* ON RANGITIRA ISLAND, NEW ZEALAND.

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ABSTRACT

Observations were made of the habitat use of *Oligosoma nigriplantare nigriplantare* on Rangitira Island, in the Chatham Island group off the coast of eastern New Zealand. The skinks were found almost entirely in grassland and shrub habitat. Very few were observed in forest. There was no indication of differences in habitat use between two colour morphs which were identified at the start of the study. Current management of Rangitira Island is touched upon in light of the findings of this study.

INTRODUCTION

The Chatham Islands are an archipelago 850 kilometers off the east coast of the South Island of New Zealand (44°S 176°E). They are considered to be of high conservation value particularly in relation to endemic birds and insects (Department of Conservation, 1996). Compared to these groups the reptile fauna is relatively depauperate being comprised of only one endemic subspecies (*Oligosoma nigriplantare nigriplantare*). This subspecies is currently confined to offshore islands in the Chathams group which lack introduced mammalian predators with the possible exception of a small relic population surviving on Pitt Island (T. Whitaker pers. com.).

The following observations were made while assisting with research on the endangered Chatham Island petrel (*Pterodroma axillaris*).

STUDY AREA

Rangatira Island is the third largest island in the Chatham Island group after main Chatham and Pitt Islands (West and Nilsson, 1994). At 218ha in size it is one of the few out lying islands in the Chathams group to support forest cover of any significance. Originally this forest cover would have been wind-shorn forest and shrublands. In the last 120 years this cover has been extensively modified by farming and it is only in the last few years that vegetation on Rangatira has returned to something like its original character (Department of Conservation, 1996). Today Rangatira is a mosaic of vegetation types from grassland to coastal forest.

In the absence of introduced mammals Rangatira has a diverse and unique fauna of birds and insects that is comparable to that of other major temperate island sanctuaries in New Zealand (Department of Conservation, 1996). For example, the breeding seabird population alone has been estimated at 1.3 million pairs (West and Nilsson, 1994).

METHODS

Ten transects of 15m in length were placed in a variety of habitats on Rangatira Island. These habitats were broadly classified into four categories (Coastal, Grassland, Bush, and Transition) (Figure 1).

Coastal: Two transects were placed on the coastal strip a few metres above the high tide mark. These transects were characterised by

Figure 1: Locality of transects on Rangatira Island (transect sites= *).

a short dense sward of grass less than 0.5m in height and rocky open areas.

Grassland: Two transects bisected grassland habitat present in clearings and round the bush edge. These transects were dominated by rank introduced grasses, bracken *Pteridium esculentum*, water fern *Histiopteris incisa* and *Muhelenbeckia australis*. One of the transects also had an extensive area of blackberry. This vegetation formed a dense sward and was generally less than I m in height.

Bush: Four transects were established in bush; two in the modified forest of Woolshed Bush, two in the unmodified Top Bush. Prominent plant species in this habitat include; *Melicytus chathamicus, Plagianthus betulinus* var. *chathamicus, Myrsine chathamica, Macropiper excelsum, Coprosma chathamica* and *Olearia traversii*. These habitats were characterised by a tall canopy > 2m in height with little understorey regeneration. The forest floor was largely bare, friable soil as a result of the very high density of seabird burrows.

Transition: Two transects started in forest and finished in grassland taking in the transition zone between these two habitats. This transition zone of approximately 2-3 metres was characterised by a dense understorey.

All but two of the transects were along tracks. This prevented damage to seabird burrows which cover most of the island.

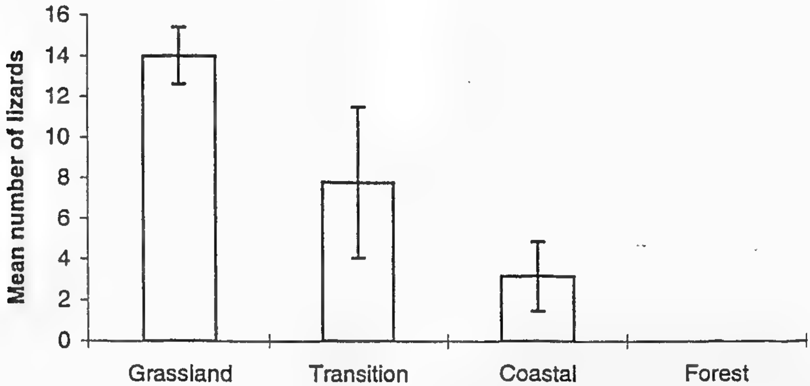
Transects were walked in the afternoon once per day for a total of six days. Each one took exactly three minutes during which time all lizards observed and heard were recorded. The lizards observed were divided into two categories (bronze and green) on the basis of

their dorsal coloration as it has been suggested that differences in coloration and patterning in Chatharn Island skinks may be indicative of there being more than one species on Rangatira Island (M. Bell pers. comm). Much of the time lizards were observed but could not be classified according to the above criteria; these animals were recorded as "heard'. No lizard was knowingly counted twice.

RESULTS

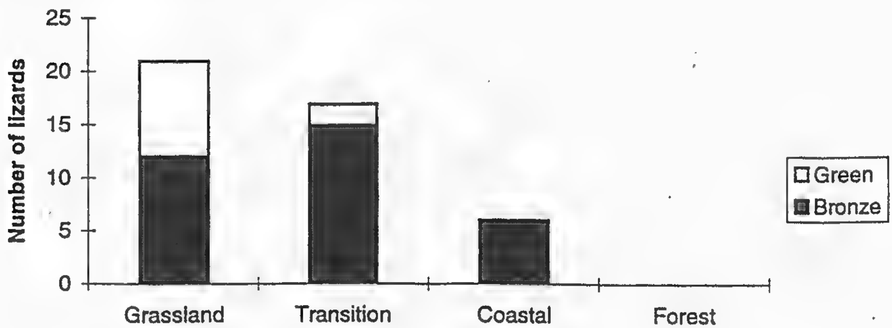
A total of 150 observations of skinks were made (84=grassland, 47=transition 19 = coastal). The majority of lizards were counted in grassland habitats (mean=14) followed by transition habitats (mean=7.8) and coastal habitats (mean=3.2) No skinks were counted in forest habitats (but see discussion) (Figure 2).

Figure 2: Mean number (±SE) of *0. n. nigriplantare* recorded in each habitat (n=6).



Forty-four of the lizards seen were identified as either a bronze (n=33) or green (n=11) form (Fig.3).

Figure 3: Ratio of green to bronze forms of *0. n. nigriplantare* in the respective habitats (n=6).



In the transects through the transition habitats all the skinks were observed in the grassland half of the transect. This meant that lizards recorded in this habitat were recorded in half the distance of the other two habitats where lizards were present.

DISCUSSION

The distribution of *O. n. nigriplantare* on Rangatira Island is largely in grassland and shrub habitats. These habitats are characterised by dense low vegetation. Only two lizards were observed outside of these habitats in the forest; both were sited near clearings where fallen vegetation had created light gaps. Both these animals used storm petrel burrows as retreats when disturbed.

There is no evidence that there is a difference in habitat use between the two "forms" supporting the view that these two forms are not different species. The presence of animals that appeared to be intermediate between the two forms in colouring and patterning (pers. obs.) further supports this view.

The current policy of the Department of Conservation is to allow the natural regeneration of vegetation on the island to continue (E. Kennnedy pers. com.). This has already resulted in many areas, which were once grassland now being forested (for example around the woolshed). As this process of succession takes place dense low vegetation will be replaced by tall forest with an open understorey, a process which has already occurred in Woolshed Bush. This will almost certainly lead to a decline in lizard numbers on Rangatira Island. Ultimately the skinks will probably become confined to the coastal strip and permanent clearings, with the odd individual intruding into the forest where light corridors create suitable basking sites. This distribution may more closely reflect the prehuman distribution of this species in the Chathams.

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ISLAND POPULATIONS : REPTILES AND AMPHIBIANS OF THE JERVIS BAY REGION ON THE SOUTH COAST OF NEW SOUTH WALES

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ABSTRACT

Field surveys and database searches revealed that 25 reptile and 17 frog species occur in the Jervis Bay region. Compared with other local zoogeographic regions, Jervis Bay has a medium species diversity of reptiles and a high diversity of amphibians. The presence of several species extended their known distribution. A suite of species associated with saxicoline habits and heath/woodland communities exist as isolated populations on either side of the bay.

INTRODUCTION

Reptiles and amphibians were studied at Jervis Bay (35° 03′ S, 150° 49′ E, altitude 0-170 m asl) on the south coast of New South Wales (Figure 1). The total area surveyed covered some 11795 ha and included Booderee (formerly ACT Jervis Bay) National Park (6312 ha), Beecroft Peninsula (4039 ha), NSW Jervis Bay National Park (1155 ha), Long Bow Point (215 ha), Vincentia (40 ha) and Woollamia (31 ha).

Geologically the Beecroft and Bherwerre Peninsula (and Bowen Island) are underlain with Permian sandstones, siltstones and conglomerates of marine origin and are part of the southern-most extent of the Sydney Basin (Douglas 1973). The peninsulas are overcapped by Quaternary to recent dunes and sandy soils (Douglas 1973). The sandstone bluffs of both peninsulas are prominent features of the landscape.

The vegetation of Beecroft Peninsula is diverse. The primary vegetation types include heath, shrubland, woodland, mangrove sedgeland, swamp, open forest and forest; with heath and shrubland being the most abundant (Skelton and Adam 1994). Heathland and Blackbutt/Bangalay *Eucalyptus pilularis/E.botryoides* forest constitute the major vegetation of Bherwerre Peninsula (Ingwersen 1973). The vegetation communities on Bowen Island include heath, sedgeland and woodland.

Three kilometres to the north of Beecroft Peninsula is Lake Wollumboola, a large semi-saline waterbody that occasionally overflows into the sea. The soil is derived from Wandrawandian siltstone. Five major vegetation communities occur around Lake Wollumboola, namely open forest, woodland, heathland, grassland and saltland heathland-sedgeland (Daly and Leonard 1996). Survey sites between Beecroft and Bherwerre peninsulas (NSW Jervis Bay National Park and Currambene State Forest) were similar to those adjacent to Lake Wollumboola in that the vegetation community was open forest, woodland and heath-sedgeland.

Jervis Bay National Park is mostly underlain with siltstone. However, small sections on Bherwerre and Beecroft peninsulas occur on sandstone. Heath and woodland are the main vegetation communities which occur on sandstone while open forest, woodland and sedgeland are common communities on the soils derived from siltstone.

The fauna surveys conducted in the region which considered reptiles and amphibians include Pollard (1973), Coyne *et al.* (1979), Brasher (1987), Braithwaite *et al.* (1988) and Mills (1989). Results of these surveys were reviewed and summarised in the current assessment.

This paper provides additional information on the region's herpetofauna and gives extensions of the known range for several species. Comments are given on species status and the possible routes of colonisation for species with isolated populations on both Jervis Bay peninsulas.

METHODS

Field surveys were conducted during late spring, summer and autumn and included direct observation of animals, pitfall trapping, drive transects, identification based on species specific calls, location of inactive animals by lifting habitat such as rocks and logs, nocturnal observations with the aid of 50 watt 12 volt spotlights and identification of frogs based on tadpole morphology.

Surveys were conducted on Beecroft between 8 March 1995-18 February 1996 for a total of 17 days (Daly 1996). Potential breeding sites for frogs were identified and revisited after rain for 6 nights in autumn and spring. Road transects totalling approximately 320 km were driven. One 20m long drift net was installed at Cabbage Tree Point. This drift net was 30 centimetres high and had three pitfall traps spaced at 10m intervals. The pits measured 23 centimetres in diameter and 28 centimetres in depth and were placed in closed forest and targeted fossorial skinks. Pits were set for 8 days in late January to early February and were checked daily.

Surveys were conducted in Jervis Bay National Park (JBNP) between 25 January and 7 May 1998 (Daly 1998). The area was visited on 17 days. Eight 0.5 ha transects were searched for reptiles, each for one person/hour at temperatures which ranged between 22-28°C. Two dry pitfall were set as above, each for 3-4 days. Two lines of three large cage traps were baited with chicken and set along sandstone ridges for 3-4 days, targeting monitors. Three searches were conducted for frogs. One targeted ponds and dams and two were along creeks for 30 min/site.

Surveys were carried out in Booderee National Park (Daly 1995) from the 9 March 1994-4 February 1995 (including Bowen Island). The area was visited on 20 days. Six separate night searches were conducted for frogs. Surveys were opportunistic along fire trails but targeted sites such as creeks, swamps and rocky outcrops.

Surveys were conducted at Long Bow Point (Lake Wollumbulla) between 23 November 1993-17 December 1993 (Daly 1994). Two lines of 5 pitfall traps, with drift fences (as above) were set from 23-30 November and 13-17 December 1993. Surveys were conducted over a larger area of Long Bow Point during 4-17 September 1996 and targeted the Green and Golden Bell Frog *Litoria aurea* (Daly and Leonard 1996).

Additional information was gained from Australian Museum records and personal communication with residents and scientists. The author has also made opportunistic sightings during other surveys of the region.

RESULTS

The reptile and frog species recorded during this survey, previous surveys or from other sources are set out in Table 1.

The Dwarf Tree Frog *Litoria fallax* was heard calling from farm dams on private property outside the nominated survey areas.

DISCUSSION

Compared to other surveys in the region (Murphy 1994, Murphy & Daly 1998) Jervis Bay had a moderate species diversity of reptiles and a high diversity of amphibians (see Table 2). This species diversity was a function of area surveyed and the range of habitats types that exist within the study area. In particular the presence of rock outcrops and wetlands was important for many species. Many of the vegetation communities within the study area allowed a high degree of solar radiation to reach the ground and this was also considered an important factor for the occurrence of many species.

The observations of *Cryptobelepharus virgatus, Demansia psammophis, Hemiaspis signata, Litoria caerulea,* and *L. freycineti* constituted range extensions (Swan 1990; Murphy and Daly 1997, pers. obs.). This is partly a reflection of the lack of survey work in the region as surveys conducted by the author five kilometres south of the area in Conjola SF/NP (Daly et al. 1998) and 15 km to the west (Parma Creek) revealed the presence of *L. freycineti*, further extending the known distribution of this species.

Several species have isolated populations on each peninsula, linked to a common geology. It is interesting to consider the dispersal route taken by these species in colonising these two blocks of uplifted sandstone which protrude from the coastal plain. Based on proximity to

Table 1. Reptiles and amphibians of Jervis Bay
Be-Beecroft Peninsula, **Bo**- Booderee National Park, **Bn**-Bowen Island, **JB**-Jervis Bay National Park, **V**-Vincentia, **LP**-Long Bow Point, **C**-Currambene State Forest (SF).
Local Status: **c**-common (>10), **u**-uncommon (5-10), **r**-rare (<5).
Source of Record: **o**-observed or heard calling during survey, **m**-miscellaneous record ie monitor scratches on tree trunks, **x**-Australian Museum records, **a** = W. Osborne, G. Merdith, R. Goldingay, Booderee NP/Beecroft staff pers. comm., Braithwaite *et al.* (1988) and Coyne *et al.* (1979).

AMPHIBIANS										
FAMILY	**SPECIES**	**COMMON NAME**	**Be**	**Bo**	**Bn**	**JB**	**V**	**LP**	**C**	**Local Status**
Hylidae	*Litoria aurea*	Green and Golden Bell Frog	a	x	o				o	c
	Litoria caerulea	Green Tree Frog		a						r
	Litoria dentata	Bleating Tree Frog	o	o		o	o		x	c
	Litoria freycineti	Freycinet's Frog	o	a		o	o			c
	Litoria jervisiensis	Jervis Bay Tree Frog	o	o				o	o	c
	Litoria phyllochroa	Leaf Green Tree Frog	o	x		o				u
	Litoria peronii	Peron's Tree Frog	o	o		o		o	o	c
	Litoria tyleri	Tyler's Tree Frog		x				o		r
	Litoria verreauxii	Verreaux's Tree Frog	a				o		a	u
Myobatrachidae	*Crinia signifera*	Common Eastern Froglet	o	o	o	o	o	o	o	c
	Heleioporus australiacus	Eastern Owl Frog		o			o			r
	Paracrinia haswelli	Haswell's Frog	o	o			o			c
	Limnodynastes peronii	Striped Marsh Frog	o	o		o	o	o	o	c
	Limnodynastes dumerilii	Pobblebonk	o	o						c
	Pseudophryne bibronii	Bibron's Toadlet	o	o		o	o	o	o	c
	Uperoleia tyleri	Tyler's Toadlet	o	o			o			c
		Total Species	13	15	2	7	9	5	8	16

REPTILES										
FAMILY	**SPECIES**	**COMMON NAME**	**Be**	**Bo**	**Bn**	**JB**	**V**	**LP**	**C**	**Local Status**
Chelonidae	*Chelodina longicollis*	Long-necked Tortoise	o	o					o	c
	Chelonia mydas	Green Turtle		x						r
Dermochelyidae	*Dermochelys coriacea*	Leathery Turtle		x						r
Varanidae	*Varanus varius*	Lace Monitor	a	a		m		a	m	r
Gekkonidae	*Oedura lesueurii*	Lesueur's Gecko	a							r
Pygopodidae	*Pygopus lepidopodus*	Scaly Foot	o	a			a			r
Agamidae	*Amphibolurus muricatus*	Jacky Dragon	o	o	o	o	o	o	o	c
Scincidae	*Ctenotus taeniolatus*	Copper-tailed Skink	o	o	o	o			a	c
	Cryptobelepharus virgatus	Wall Skink					o			r
	Cyclodomorphus casuarinae	She-oak Skink	a	a			o			r
	Eulamprus quoyii	Eastern Water-skink	o	o	o	o	o	o	o	c
	Eulamprus tenuis	Barred-sided skink							a	r
	Lampropholis delicata	Dark-flecked Sunskink	o	o	o	o	o	o	o	c
	Lampropholis guichenoti	Pale-flecked Sunskink	o	o		o				c
	Pseudemoia platynota	Red-throated Skink	a	o						r
	Saproscincus mustelina	Weasel Skink	o	o		o			a	u
	Tiliqua scincoides	Common Bluetongue	o	o		a	a	x		u
Boidae	*Morelia spilota spilota*	Diamond Python	a	a						r
Elapidae	*Acanthophis antarcticus*	Death Adder	a	x						r
	Demansia psammophis	Yellow-faced Whip Snake	o							r
	Hemiaspis signata	Marsh Snake	a			o	a	o		r
	Pseudechis porphyriacus	Red-bellied Black Snake	o	o	o	o	o	o	o	c
	Pseudonaja textilis	Eastern Brown Snake	o	a			a			r
	Rhinoplocephalus nigrescens	Small-eyed Snake		a		o	o		o	r
Hydrophiidae	*Pelamis platurus*	Yellow-bellied Seasnake		a						r
		Total Species	19	20	5	11	12	7	9	25

Table 2. Reptiles and amphibians recorded in various areas of the NSW South Coast.

Study Site	Study	Reptile species	Frog species	Size of study area (ha)
North-west Nowra	Murphy and Daly (1998)	**26**	**13**	**2590**
Seven Mile Beach NP	Murphy (1994)	**17**	**9**	**898**
Jervis Bay Region	current survey	**25**	**17**	**11795**

nearest suitable habitat it appears that these species colonised the peninsulas from the west. The minimum distance between the areas which have exposed sandstone at Bherwerre Peninsula and similar geology at upper Parma Creek is approximately 10 kilometres.

The vegetation communities which occur at Parma Creek and Jervis Bay include a suite of common heath and woodland species, however there are several rare plants which occur in both localities. These include *Acacia subtilinervis, Leptospermum epacridoideum* and *Grevillea barklayana* (Mills 1983, 1993). The occurrence of these rare species which have very restricted distributions indicates that these two areas were probably linked in the past by a contiguous belt of heath/woodland.

The species which probably invaded from the west are those with saxicolous habits or are strongly associated with heath/woodland and include *Oedura lesueurii, Pygopus lepidopodus, Ctenotus taeniolatus, Cryptoblepharus virgatus, Lampropholis guichenoti, Pseudemoia platynota, Acanthophis antarcticus, Demansia psammophis, Litoria freycineti* and *Heleioporus australiacus*.

There are however some striking anomalies. For example the Heath Monitor *Varanus rosenbergi*, Cunningham's Skink *Egernia cunninghami*, White's Skink *E. whitii*, Black Blind Snake *Ramphotyphlops nigrescens* and Broad-headed Snake *Hoplocephalus bungaroides* are associated with sandstone exfoliations/woodland to the west in Morton National Park (pers. obs.) and yet they were not detected in the survey area. Similarly the Water Dragon *Physignathus lesueurii howittii* occurred 10 kilometres to the north west of the bay along Currambene Creek and yet was not detected in the study area. Either these species failed to colonise the area or have become extirpated.

Bowen Island had a low species diversity of herpetofauna because of the small area (51 ha) and the extensive clearing associated with agriculture during the 1940's. The finding of *L. aurea* was significant because the species is listed as endangered under the Threatened Species Conservation Act 1995. The population has also probably been isolated from that which occurs on the mainland for some 5000 years (Osborne *et al.* 1996). There is, however, a possibility that *L. aurea* was translocated to the island.

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ADDENDUM

On 21 November 1999, Mr C Senior caught *Uperoleia laevigata* in Booderee NP. This represents an additional species for the region.

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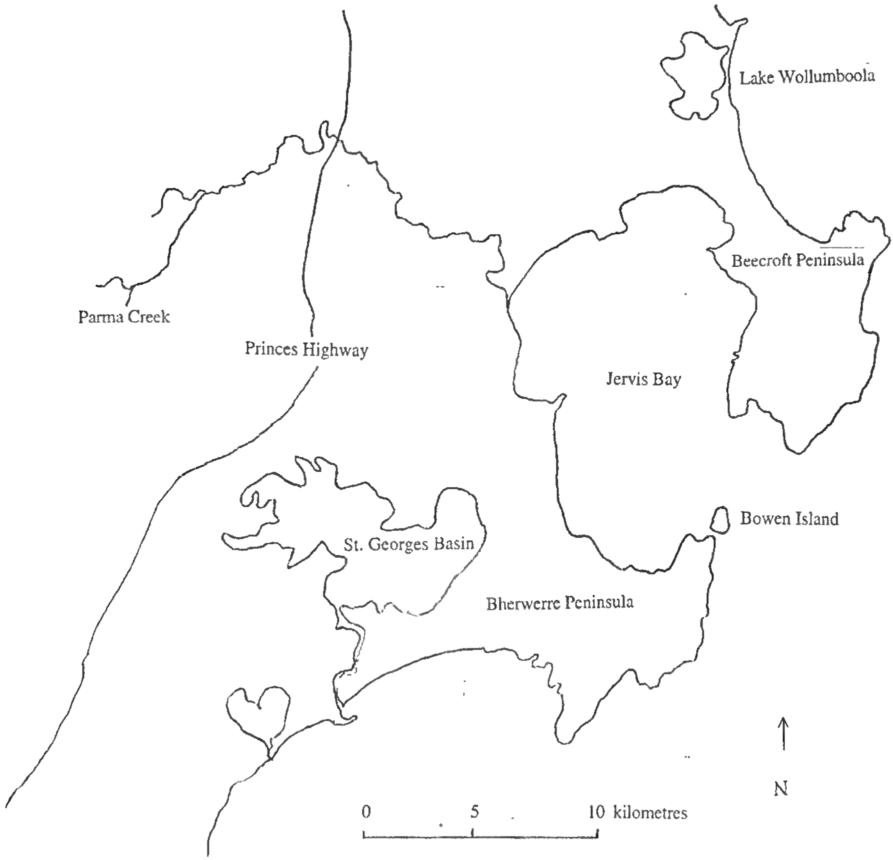
Figure 1: The Jervis Bay region



NOTES ON A WINTER AGGREGATION SITE, DIURNAL ACTIVITY AND DIET FOR THE BROWN TREE SNAKE *BOIGA IRREGULARIS* IN NORTHERN NEW SOUTH WALES.

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INTRODUCTION

A rock crevice overwintering site and diurnal basking are described for the normally arboreal, nocturnal Colubrid snake *Boiga irregularis*. Additional observations of bird eating are reported.

OBSERVATIONS

A communal shelter site used by three adult *B. irregularis* was discovered in a disused quarry in Whian Whian State Forest, northeast of Lismore, NSW on 23rd July 1997. Precise co-ordinates for the location are not given; the fragile rock formations of the site are distinctly dangerous and liable to collapse if approached too closely.

The shelter site utilised by the three snakes consists of vertical crevices in an exposed rock face which had been disturbed by quarrying. A vertical pillar-like segment of exfoliating basalt had been partially dislodged from the parent rock providing a crevice which appears to permit access to deeper cavities or crevices.

Inspection of a north-facing vertical ~ 4 metre rock face within the quarry revealed a nearly entire sloughed skin of approximately 1.5 metres. This was identified as from *B.irregularis* by its possession of 19 mid-body row scales, a distinctive large shield-shaped frontal scale, large spectacle, enlarged vertebral series and by its slender shape.

An active adult *B. irregularis* was seen moving within a crevice, and 2 additional adult snakes were coiled together on a narrow rock shelf in weak filtered sunlight at 1045 EST on the day the site was located.

Air temperature was estimated to be ~ 16 degrees Celsius. Although the snakes were not captured or precisely measured, they were estimated to be approximately from 1.2 to 1.5 metres in total length. These are large adults for the northern NSW population (pers. obs.).

Apparently disturbed by my close approach, the three snakes retreated into the crevice, ultimately disappearing in deep crevices.

Numerous deposits of uric chalk and a pile of scats adjacent to vertical crevices in the rock were also observed. The scats had weathered into a whitened state, and as recent weather had been almost continually overcast and wet, it is likely that scats had been deposited at the site at least a month before discovery on 23rd July 1997. While it is not possible to establish the precise duration of occupation of the site, the above evidence suggests a prolonged period of occupation.

Scats contained feathers and were collected for analysis of dietary items.

The site was revisited on 25th July 1997 where a single adult *B. irregularis* was seen emerging from the crevice. Rain had recently ceased and the rockface was receiving weak sunlight. The snake retreated to the crevice after my approach and no further observations were made on this visit.

On 26th July the first sunny break after several days of rain occurred and the site was examined at 1115 EST. Three adult *B. irregularis* (presumably the same three individuals seen on 23rd) were found basking in full sun. One was sheltering partly within the crevice (see Figure 1), one was coiled in the base of Crofton Weed (*Ageratina adenophora*) at the base of the shelter site crevice (see Figure 2),

and the third snake was coiled in the base of a grass tussock (*Paspalum sp.*) approximately 1.1 metres from the shelter site. On this occasion they remained apparently undisturbed by my presence and the shelter sites and snakes were photographed without their retreating. Air temperature was ~ 16 degrees Celsius, there was 50% cloud cover and no wind.

Figure 1: Adult *B. irregularis* basking within the crevice.

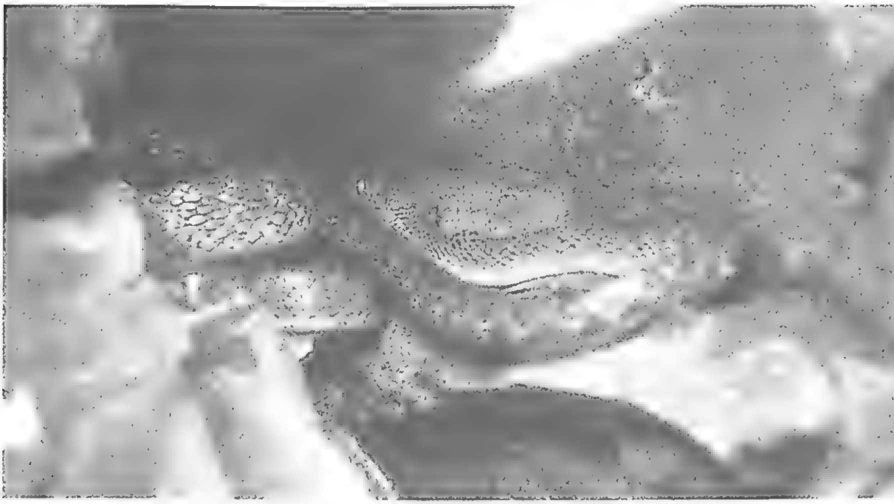

Figure 2: Adult *B. irregularis* basking in full sun on rock surface.

A further instance of diurnal behaviour was recorded on 31st October when one snake was seen moving in the early afternoon in full sun. Air temperature was ~ 24 degrees. Brown Tree Snakes were observed at the site on each subsequent visit (2-3 per month) until November 1997. Snakes were not recorded at the site subsequently and it is assumed that that they had left the shelter in early November.

The extent of vegetative growth in the quarry indicated that there had been little if any quarrying activity in the previous two years. Vegetation in the immediate area is wet sclerophyll forest dominated by White Mahogany (*Eucalyptus acmenoides*). Other canopy species include Turpentine (*Syncarpia glomulifera*), Brush Box (*Lophostemon conferta*) and Pink Bloodwood (*Corymbia intermedia*). Understorey vegetation is dominated by Lantana (*Lantana camara*) and shrubby Sally Wattles (*Acacia melanoxylon*), with Tree Heath (*Trochocarpa laurina*) and sapling eucalypts. Crofton weed (*Ageratina adenophora*) and Blady-grass (*Imperata cylindrica*) are the dominant plants in the quarry. Elevation is ~ 320 m asl.

DIET

Analysis of a scat located at the aggregation site (pers. comm., Ian Mason, CSIRO) reveals that a medium-sized passerine , possibly a Chowchilla (*Orthonyx spaldingi*) or Whipbird (*Psophodes olivaceous*) had been consumed, perhaps by one of the 3 snakes observed at the aggregation site.

Elsewhere in the same State Forest on the 10th of December 1997 an adult *B.irregularis* was located with 3 birds in the gut. One bird, tentatively identified as a fledgling Lewin's Honeyeater, (*Meliphaga lewini*) was palpated to the snake's mouth before being replaced.

In lowland coastal northeastern NSW *B.irregularis* are commonly encountered preying upon cage birds, and occasionally on mice in the writer's captive mouse colony (pers. obs.).

Brown Tree snakes are recorded as consuming a wide range of vertebrates from fish, lizards and frogs to birds and their eggs and mammals. There is an ontogenetic shift in diet from ectothermic to endothermic vertebrates as snakes increase in size. (Greer, 1997).

DISCUSSION

Aggregation is reported for this species "in small colonies in rock crevices and hollow tree limbs ...in the scaffolding of bridges and viaducts.....among rafters in barns and disused buildings" by Gow (1976), and in "caves and buildings" by Wilson and Knowles (1988).

Seasonal aggregation (winter) for this species is reported by Swan (1990), Hoser, (1980) and Covacevich and Limpus (1973). In the latter case 3 adult and 2 juvenile males were recorded from a winter aggregation in south-east Queensland of "30-40 specimens of *B. irregularis, Dendrelaphis punctulatus* and *Morelia spilota variegata*", assumed to be aggregated for thermoregulatory reasons (*op.cit.*). Seasonal aggregations are seldom reported for Australian snakes. In particular, winter 'hibernacula' are uncommon, perhaps due to the generally mild climate on this continent.

A further winter aggregation for *B. irregularis* in Sydney is reported from a honeycomb formation in a cave in a sandstone ridge (Hoser, 1980).The aggregation consisted of five snakes (two adults, two sub-adults, one juvenile). A late spring (November) aggregation of four *B. irregularis* (two adults, one sub-adult, one juvenile) in a rock crevice, is reported from the NSW Central Coast (Hoser, 1980).

Climate in the area of the aggregation recorded in the current report is described as a "sub-tropical .... with heavy summer rainfall and a relatively dry winter."(CSIRO, 1995). At this elevation (320m) there is little or no risk of frost. Hollow-bearing trees are available in the near vicinity and it is likely that aggrega-

tion of these snakes is for social purposes rather than for enhanced survival of severe winter conditions.

Brown Tree Snakes are described in literature as nocturnal (Gow, 1976; Greer, 1997; Ehmann, 1992, Wilson and Knowles, 1988). Diurnal behaviour in this species is rare, and basking, to my knowledge, is not reported in the literature. However, anecdotal reports of covert basking from within deep horizontal sandstone crevices in the Sydney area are known.

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The manuscript was improved by suggestions from an anonymous reviewer

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SPOTTED BARRAMUNDI PREDATION UPON *EMYDURA KREFFTII* AND *CHELODINA EXPANSA* HATCHLINGS IN CENTRAL QUEENSLAND.

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Little is known about the predators of Australian freshwater turtle hatchlings. Worrell (1966) observed herons, cormorants, kookaburras, crocodiles, goannas, red-bellied black *(Pseudechis porphyriacus)* and mainland tiger *(Notechis scutatus)* snakes feeding on hatchlings. Cann (1978) recorded recently-hatched *Emydura krefftii* eaten by a Mulga snake *(Pseudechis australis)*. Though large carnivorous fish are believed to be a major predator of hatchling turtles in aquatic habitats (Gibbons 1970; Wilbur 1975; Mitchell 1988), Chessman (1978) could find no evidence of fish predation in southeastern Australian turtle species and Parmenter (1976) did not discover any turtle remains in gut contents of long-finned eels *(Anguilla reinhardtii)* from the Wollomombi River near Armidale, New South Wales. Previously, the only documented observation of fish predation upon Australian hatchlings was by Murray Cod (*Maccullochella macquariensis*) (Worrell 1963) and freshwater eels (Cann 1978).

Eight spotted barramundi or saratoga *(Scleropages leichardti)* were caught on 14 December 1995 at Lake Plattaway, Central Queensland (148°57.2'E; 22°25.9'S) then fixed and stored in 10% formalin. Dissection revealed fresh *Emydura krefftii* and *Chelodina expansa* hatchlings in the stomachs of 2 fish. Morphometrics of the hatchlings and fish are presented in Table 1.

None of the hatchlings demonstrated anomalous scale counts or deformities. Hatchling 1 (Fish 1) and 3 (Fish 2) had an umbilicus scar and a caruncle (egg tooth) remnant, and no growth expansion around the areolar area on their carapacial scutes. All of these characteristics suggest a recent emergence from the nest. The limited areolar area of growth on the marginal scales of Hatchling 2 (Fish 1) suggests hatching probably occurred late in the prior season, allowing little time for growth before its first winter (Georges 1982). *E. krefftii* on Fraser Is., Queensland, nest from September to January (Georges 1983), with hatchlings emerging from November until March (Georges 1982). These periods coincide with presence of the youngest *E. krefftii* hatchlings in fish gut contents from Lake Plattaway. The *C. expansa* hatchling did not show an umbilicus scar or caruncle. There was no growth beyond the areolar area, indicating the hatchling had most likely emerged from the nest late in the preceding autumn. *C. expansa* reproduction follows the wet/dry tropical pattern of Legler (1985) with incubation periods being amongst the longest of any chelonian (Ewert 1979). Legler (1985) reported constant temperature incubations varying from 126 days (30°C) to 303 days ("23°C" laboratory ambient) while Goode and Russell (1968) reported field incubation periods in the southern limits of the species range normally exceeding 324 days and lasting as long as 522 days (until hatchling emergence). Incubation period and oviposition timing (February to August, Legler 1985; March to May, Booth 1998) ensure that all *C. expansa* eggs spend a minimum of one winter in the nest. Legler (1985) calculated that all hatchlings from all nests in the tropics would be out of the nest by the start of December, however Hatchling 4 of the present sample was taken in mid-December, without apparent umbilicus or caruncle remnant, and no growth beyond the areolar area. All of these characteristics lend to a late autumn emergence from the nest for this specimen, followed by a spring with poor food resource, or that it had spent a second winter in the nest, this time as a hatchling, held there by lack of rainfall need-

ed to soften the nest plug and stimulate emergence.

The natural distribution of the spotted barramundi is limited to the Fitzroy River System of central-eastern Queensland (Merrick and Schmida 1984), well within the range of both *E. krefftii* and *C. expansa* (Cogger 1994).

The fish are aggressive carnivores, predominantly feeding on aquatic and terrestrial insects, in addition to small fishes, yabbies and frogs (Merrick and Schmida 1984).

Usually a surface feeder, spotted barramundi spend much of the summer patrolling the surface (Merrick and Schmida 1984; Allen 1989) of still or slow flowing waters (Allen 1989). They may also be observed among aquatic vegetation (Allen 1989), where it is presumed they found the turtle hatchlings. This presumption is supported by the presence of fragments of unidentified macrophyte (Fish 1), filamentous green algae (Fish 2), and the filamentous cyanoprokaryote *Oscillatoria* sp. (Fish 2) that were wrapped around the turtle carcasses. Hair fragments, from an unknown source, were also isolated from both fish stomachs.

Little is known about microhabitat selection by Australian freshwater turtle hatchlings, however studies of North American species show that they prefer shallow aquatic areas surrounding emergent root masses (Pappas and Brecke 1992) or with large quantities of submerged and emergent aquatic macrophytes and non-aquatic vegetation (Janzen *et al.* 1992). They have been observed basking on and at the base of sedge tussocks, on low branches, at the base of root interstices (Pappas and Brecke 1992), on floating wood and emergent logs up to several metres from shore (Janzen *et al.* 1992). Despite the importance of aquatic and aerial basking during thermoregulation by turtles these observations are few, probably due to the considerable risk of predation. When disturbed, some individuals retreated to holes, burrows or openings at the base of sedge tussocks (Pappas and Brecke 1992).

It is this retreat to refugia, or hiding in the soft substrate (Cann 1978; Britson and Gutzke 1993), that is likely to be the first defense against predation. Several studies demonstrating an absence of hatchling turtles in North American largemouth bass *(Micropterus salmoides)* gut contents have concluded that the hatchlings must also utilise anti-predator mechanisms. Hatchlings were often attacked, but then egested (Semlitsch and Gibbons 1989; Britson and Gutzke 1993). This may be due to the hatchling clawing and biting (potentially harmful to the gill apparatus and digestive tract, Britson and Gutzke 1993) or that the structure of the shell prevented them being swallowed (Semlitsch and Gibbons 1989). Red-bellied black snakes have been observed to regurgitate *Chelodina* sp. hatchlings after attempted swallowing, when the carapace would not pass through their jaws (Cann 1978). While the presence of a noxious smell as a deterrent did not appear to be an influence in either study with the largemouth bass, it may aid hatchlings of the Australian snake-necked turtle *Chelodina longicollis.*

Despite the difference in fish length, each contained only 2 hatchlings, which seemed to have reached the stomach capacity of each fish. Gape and gut volume are likely to limit predation pressure per fish during periods when hatchlings are numerous and accessible. The appearance of hatchlings as gut contents of local freshwater fish is rare with these two instances being the only cases observed during 25 years of dissection classes averaging 1.5 saratoga per year, plus many other carnivorous species (D. K. Morris, pers. comm.). Lake Plattaway is an anabranch of the Connors River, only connected during major flood events. The prolonged drought conditions of 1995 had resulted in the lake being reduced to about half its depth (though not significantly reducing its extent) and the loss of virtually all aquatic macrophyte growth (N. Sawtell, pers.comm.). These conditions of reduced cover for turtle hatchlings may well explain the high incidence of their predation by the saratoga (2 of the 8 fish taken at the 1995 capture). Saratoga taken from the same precise site in previous years did not have freshwater turtle hatchling as gut contents (C.J. Parmenter, D. K. Morris, unpubl. data). These

data infer that any substantive drawdown of waterhole volumes leading to depletion of macrophyte beds, may result in markedly increased rates of fish (and other?) predation on young turtles.

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Table 1. Morphometrics of Spotted Barramundi and Turtle Hatchlings from Lake Plattaway, Qld

	Sex	Length		Measurement (cm) SCL	SCW	PL	PW	SD	HL	HW
Fish 1	Female	65cm	Hatchling 1 *E. krefftii*	3.32	3.10	2.78	1.51	1.69	1.34	1.06
			Hatchling 2 *E. krefftii*	3.51	3.57	2.59	1.40	1.66	1.39	0.98
Fish 2	Male	50cm	Hatchling 3 *E. krefftii*	3.27	2.82	2.69	1.28	1.53	1.26	1.00
			Hatchling 4 *C. expansa*	3.96	*	2.95	1.55	1.44	2.00	1.15

(SCL straight carapace length; SCW straight carapace width; PL plastron length; PW plastron width; SD shell depth; HL head length; HW head width)

*SCW not possible due to bites on carapace during predation

RAMPHOTYPHLOPS ENDOTERUS (WAITE, 1918), AN ADDITION TO THE TYPHLOPID FAUNA OF NEW SOUTH WALES.

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The typhlopid snake fauna of western New South Wales is very poorly known. Even as late as 1990, Swan (1990) recorded only a single species, *Ramphotyphlops bituberculatus*, from west of the Darling River, and only five localities for that species. This note reports the occurrence of a second species, *Ramphotyphlops endoterus* (Fig.1) from north-west NSW, collected during herpetofaunal surveys of the National Parks of the west of the state by the Australian Herpetological Society. Specimens are lodged in the Australian Museum, Sydney.

At Mootwingee National Park, three specimens of *R.endoterus* were collected: R146247-48, a pair found mating under a log in Mitchell grass and shrubland on red sandy soil at 31°17'S 142°15'E, collected 25.x.1994, and R150231, active at 2100hrs during an electrical storm with light rain and warm humid conditions on the road to Mootwingee Gorge at 31°18'S 142°17'E, collected 2.xi.1996, in open shrubland on red loamy soil. A fourth specimen was found on the same night and site as R150231, but not collected, and a fifth observational record is in the NSW National Parks and Wildlife Service Wildlife Atlas database (SMVE 96112603, 31°17'S 142°14'E, 22.x.1996).

At Sturt National Park, 14 specimens were collected from nine sites: 3.4km N Middle Rd turnoff via Cameron's Corner rd, at 29°02'S 141°11'S (R151640, 31.x.1997; R151736, 5.xi.1997; R155225, 3.xii.1999; R155429, 8.xi.1999); 13.5km E Cameron's Corner rd via Middle Rd, at 29°02'S 141°18'E (R151636, 31.x.1997; R151740, 5.xi.1997); Lake Pinaroo, Fort Grey Basin, adjacent to the Fort Grey campsite, at 29°05'S 141°13'E (R152987, 30.ix.1998); 5.7km W Cameron's Corner Rd via Whitecatch Rd, at 29°07'S 141°08'E (R155217, 3.xi.1999); 9.8km W Binerah Downs ruins via Middle Rd, at 29°01'S 141°27'E (R155271, 4.xi.1999); along Whitecatch Rd, at 29°10'S 141°05'E (R155294, 4.xi.1999); 1.8km W Cameron's Corner Rd via Whitecatch Rd, at 29°06'S 141°10'E (R155296, 4.xi.1999); 2.7km W Binerah Downs ruins via Middle Rd, at 29°01'E, 141°31'E (R155413-14, 8.xi. 1999); 13.7km E Cameron's Corner Rd via Middle Rd, at 29°02'S 141°18'E (R155423, 8.xi.1999). Most specimens were pit-trapped on the crest and upper slopes of red clayey sand dunes (Fig. 2). The exceptions were R152987, collected by hand in coolabah/mulga woodland, and R155423, pit-trapped on a swale of sandy red earth. All of the Sturt National Park records were collected shortly after (within ten days of) wet weather.

Morphological variation among the collected specimens is within or close to previously known limits (Storr, 1981; Aplin & Donnellan, 1993; note that the reference points for dorsal scales in the latter paper are different from those given here). All have a broad rostral scale, the nasal cleft contacting the preocular, and 22 midbody scales. The five females have dorsal scales 436-462 (mean = 450.4, sd = 9.53), counted from the frontal to the scale bordering the terminal spine inclusive, subcaudal scales 9-12 (mean = 10.4, sd = 1.52), snout-vent length (SVL) 268-296.5mm (mean = 284.6mm, sd = 12.06mm) for four adults, and 141.5mm for a juvenile, tail length 1.38-1.87% of SVL (mean = 1.73, sd = 0.20), and body width 1.63-2.43% of SVL (mean = 2.02, sd = 0.33). The twelve males have dorsal scales

434-463 (mean = 447.0, sd = 7.46), subcaudal scales 10-18 (mean = 14.9, sd = 2.47), SVL 175.5-255mm (mean = 215.5mm, sd = 18.52mm), tail length 1.57-4.15% of SVL (mean = 3.13, sd = 0.80), and body width 1.72-1.98% of SVL (mean = 1.85, sd = 0.09). The apparent dimorphism in size is consistent with knowledge of other *Ramphotyphlops* species (Shine & Webb, 1990).

All NSW records are from red sandy to loamy soil rather than stony soils. As such soils are not continuously distributed in north-western NSW, it is possible that the species is not continuously distributed between the widely separated northern and southern localities (Fig. 3). However, at least in Sturt National Park, the species was recorded from most pit-trap sites we established in the sand-dune country in the west of the Park, and it is likely to occur throughout this habitat. Although population sizes of typhlopid snakes are difficult to determine, due to the generally serendipitous nature of their collection, the species was one of the five most common reptile species pit-trapped in sand-dune habitats in Sturt National Park (the other four being the lizards *Ctenophorus fordi, Ctenotus brooksi, Eremiascincus fasciolatus* and *Diplodactylus damaeus*).

On the basis of the first two specimens collected from Mootwingee National Park, *R. endoterus* was rapidly listed as an Endangered Species under the NSW Threatened Species Conservation Act, 1995. The justification for this listing was that the species was known from only two specimens from a single locality at the eastern extremity of its national range, and there was consequently a possibility of genetic introgression, one-off catastrophic effects, or habitat degradation by feral goats resulting in the likely extinction of the species in NSW (D. Lunney, pers. comm.). The additional material reported in this paper markedly extends its known distribution in NSW, and casts doubt that any of the perceived "threatening processes" apply to the species as a whole in NSW. We do not believe that its present legislative status is warranted.

The addition of this species to the NSW fauna raises the number of typhlopid species to nine for the state, the others being *R. affinis, R. australis, R. batillus, R. bituberculatus, R. ligatus, R. nigrescens, R. proximus* and *R. wiedii* (Swan, 1990; Shea, 1999). *R. endoterus* is easily distinguished from most other NSW species in having the combination of 22 midbody scales, a broad, almost circular rostral scale, and the nasal cleft reaching the preocular scale. Although occasional specimens of *R. australis* also show this combination of characters, this species has a much lower dorsal scale count (males 312-334, mean = 324.3, sd = 6.92, n = 11; females 327-347, mean = 337.1, sd = 5.64, n = 8, based on NSW specimens; Appendix 1) than *R. endoterus*.

Although the NSW NPWS Wildlife Atlas contains a sight record for *R. australis* for the Sturt National Park region (Record 26619-035, 29°09'S 141°37'E, 25.ii.1972), and another for the Broken Hill area (Record 112991-035, 31°55'S 141°25'E, 1.x.1994), there are no specimen-based records for this species from the north-west of the state. Given the similarity between *R. endoterus* and *R. australis*, it is probable that at least the first, and possibly also the second, is a misidentified *R. endoterus*. Typhlopid snakes are difficult to identify accurately without recourse to microscopic examination, and these probable misidentifications highlight the necessity of taking voucher specimens for this group of reptiles.

The record of a mating pair on 25.x.1994 is the first data on timing of reproduction in *R. endoterus*. Curiously, the female of this pair lacks enlarged ovarian follicles, indicating that sperm storage is highly likely to take place in the female.

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APPENDIX 1. Comparative material of *Ramphotyphlops australis*. All records from NSW.

R1197, Narrandera; R11556, Euabalong West; R14884, Leeton; R15496, Rankins Springs; R27925, R27927, R29685-86, R40479-80, R40821, R41091, Round Hill; R40866, Roto; R55999, Hartwood, nr Nymagee; R114432, 3.3km S Poo Poo Tank; R135436, 13mi NNW Barellan; R140991, Dareton; R147160, "Burtundy" Stn; R153203, "Boree Plains" Stn.

Fig. 1. *Ramphotyphlops endoterus* from Mootwingee National Park. Photograph: G. Shea

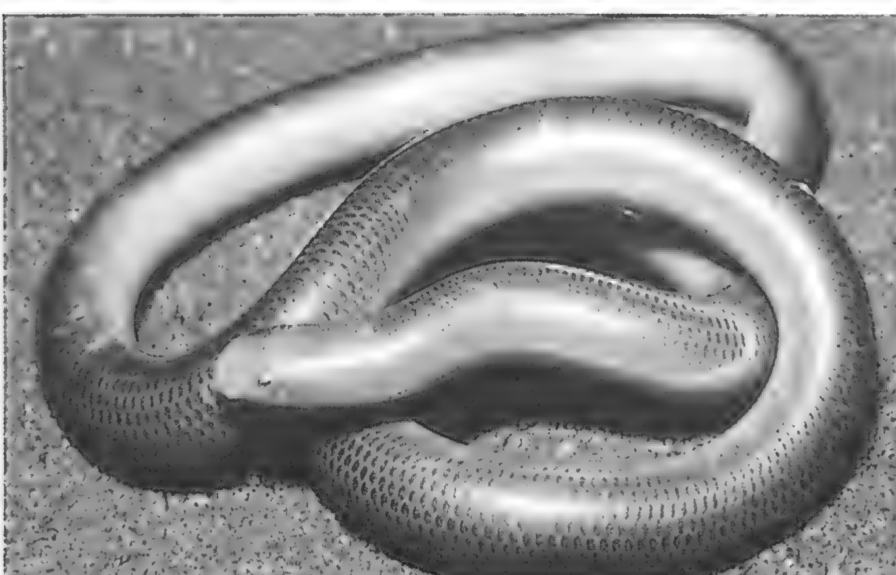
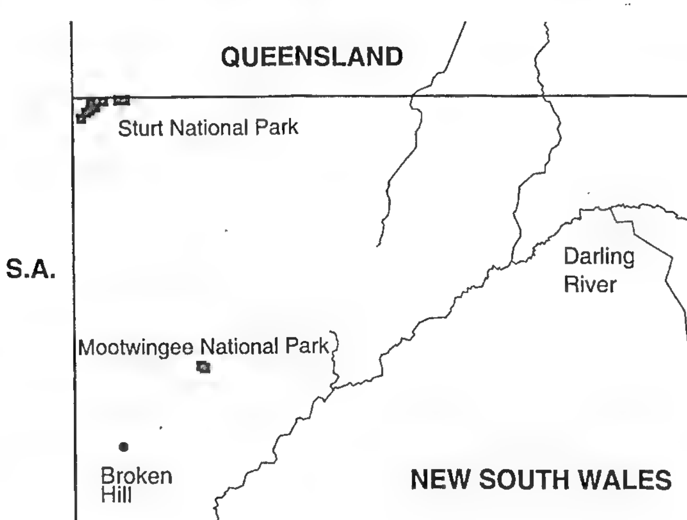


Fig. 2. Sand ridges at 13.5km E Cameron's Corner rd via Middle Rd, Sturt National Park, habitat of *R. endoterus*. Photograph: P. Harlow

Fig. 3. Distribution of *R. endoterus* in NSW.



A BREEDING OBSERVATION OF THE STUTTERING FROG (*MIXOPHYES BALBUS*) IN NORTHERN NEW SOUTH WALES

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ABSTRACT

This study reports on an observation of breeding and oviposition of the Stuttering Frog (*Mixophyes balbus*) in north-eastern New South Wales. Amplexus took place at approximately 2.20 am after local flooding had receded. Over the next six hours and 50 min the female moved 15 m upstream and constructed eight nests (depressions) within an 80 cm x 50 cm area. Nests occurred in water up to 4 cm deep. Oviposition took place in 2 cm of water during daylight before the frogs separated and moved into nearby stream bank vegetation. The spawn was estimated to contain 250 eggs in four main egg clumps, adhered to gravel and detritus. Embryos hatched between 7-14 days after oviposition with a seemingly high success rate. Hatching tadpoles ranged between 6-10 mm total length.

INTRODUCTION

The Stuttering Frog (*Mixophyes balbus*) is a large Myobatrachid species (max 80mm snout vent length) found along the upper coastal catchments from Girard State Forest (Tenterfield) in northern NSW to Dampier State Forest (Narooma) in southern NSW (Lemckert *et al.* 1997; Mahony *et al.* 1997; Daly 1998). *Mixophyes balbus* favours high order streams (normally 1st and 2nd order) associated with rainforest, wet sclerophyll, and occasionally dry sclerophyll forests (Barker *et al.* 1995; Cogger 1995; Robinson 1995; Mahony *et al.* 1997; NPWS 1998). The historic range of *M. balbus* extended south in eastern Victoria from which it has apparently disappeared (Mahony *et al.* 1997).

Mixophyes balbus is regarded as threatened in New South Wales where it is listed as a "vulnerable species" on the *Threatened Species Conservation Act 1995*. Small isolated populations remain in the southern part of its current range (Lemckert *et al.* 1997; Daly 1998; NPWS 1998) while historic populations immediately north of Sydney have disappeared (Mahony 1993). Further observations in north-eastern NSW have shown a decline in *M. balbus* (Mahony 1993). The largest known populations occur in the Dorrigo region (NPWS 1998). The causes for the decline of *M. balbus* are not clear, however the following factors have been implicated: habitat destruction and modification through native vegetation clearance (NPWS 1998); degradation of habitat e.g. pollution from cattle faeces, increased sediment loadings from cattle grazing/watering and forestry practices (Mahony *et al.* 1996 cited in NPWS 1998); direct damage to oviposition sites from cattle (NPWS 1998); predation by introduced animals (Mahony *et al.* 1996 cited in NPWS 1998); drought (NPWS 1998); and disease (Berger *et al.* 1998).

Oviposition has been previously observed on two occasions at Gloucester Tops on the mid-north coast of NSW (Knowles *et al.* in prep. cited in NPWS 1998). Nests were constructed in very shallow riffles in mid stream gravel. Nests were hollowed out (10 cm diameter and 3 cm deep) with approximately 500 eggs (Knowles *et al.* in prep., cited in NPWS 1998). Eggs were adhered and mixed with the gravel (Knowles *et al.* in prep., cited in NPWS 1998). The following account is a detailed description of a breeding/oviposition observation on *M. balbus* on the 16 February 1999.

STUDY AREA

The Timbarra Plateau is located 25 km east-south-east of Tenterfield on the northern tablelands of NSW. The Timbarra region represents the northern range limit for *M. balbus* (Mahony *et al.* 1997; NPWS 1998; Lewis (a) in prep). Many streams on the plateau are spring fed and support rainforest/wet sclerophyll riparian habitats. Location of the study area (Long: 152° 19'. Lat: 29° 08') is within the boundaries of the Timbarra Gold Project (Mining Leases 1386 & 1426).

The habitat at the observation site consists of wet sclerophyll forest (Brushbox (*Lophostemon confertus*), Sydney Blue Gum (*Eucalyptus saligna*), New England Blackbutt (*Eucalyptus campanulata*) with fringing cool temperate rainforest (Coachwood (*Callicoma serratifolia*) dominant) along a second order stream. Disturbance in the form of exploration mine drilling has occurred on a 70 m section on the southern side of the stream. Part of the breeding observation occurred within this disturbed area, however oviposition occurred further upstream. The stream is dominated by riffle zones with occasional deeper pools (< 50 cm deep) and has a dominant substratum of gravel (granite origin) and leaf litter /organic debris.

OBSERVATION AND DISCUSSION

Whilst conducting a transect count of *M. balbus* on the 16 February 1999 I observed two frogs in amplexus at 2.20 am. Air temperature and water temperature were 20.5°C and 18°C respectively while humidity was 90%. At the time of the observation, there was an absence of both cloud cover and wind. This followed weeks of rain which saw local flooding at Timbarra (Poverty Point). When first observed, the pair was approximately 30 cm from a stony riffle section of the creek. It is presumed that amplexus had only recently commenced (<20 min) because I had been recently (25 min prior) conducting radio telemetry studies of *M. balbus* in this vicinity. Six other male frogs were located close by (< 5 m radius). Chorusing groups of male frogs had been observed throughout the night.

Over the next 60 min the pair moved upstream through seemingly suitable egg deposition sites (see NPWS 1998) into an area of debris where many small riffles existed. They remained in this area for 40 min before moving a further 2.5 m upstream into an undisturbed area with larger pools. By 4.45 am (45 min latter) they had moved a further 2 m upstream and positioned themselves against the stream bank with a leaf litter substrate. At 5.25 am the pair had moved 1 m back downstream to an area of leaf litter in a small side stream although it still formed part of the major stream. At 5.50 am the frogs had not moved but appeared to be partially buried down in water and leaf litter. Between 6.05-7.00 am the female had excavated four depressions. Depressions were excavated by kicking her legs in an outward motion (mainly at 30-40 sec intervals) for 1-2 min then moving to a different angle (approx. 90°). This was observed on five occasions. The microhabitat is best described as a side riffle covered by organic matter underlain by gravel. At 7.04 am the female hopped out of this depression and continued to make three more depressions over the next hour. Between 8.00-9.00 am the pair had settled down in a relatively exposed position and remained in amplexus. I suspect this was the time when the majority of the eggs were laid. Movement then commenced at 9.09 am and at 9.10 am the male leapt off the female and moved 2.75 m up and across the stream into an overhanging rock located within a riffle zone of the main stream. Shortly after the female also left the nest but resided in the riffle zone of the stream. At 9.43 am the two frogs started calling and this lasted for 90 sec. The call emitted by the female was a similar vocalisation to that of a distress call when handled. The female then moved out of the riffle zone into nearby riparian vegetation with a dense groundcover. Observation of the frogs ceased at 9. 55 am. Amplexus was recorded for a minimum total time of six hours and 50 min with almost half of this time occurring during daylight (6.00 am sunrise).

Further inspection of the depressions (8 in total, average 10 cm diameter) revealed four main egg masses (a few small scattered ones) with an estimated total of 250 egg capsules. Depressions were evenly spaced over an 80 cm x 50 cm area, averaging 15-20 cm distance between each depression. This behaviour may indicate the female was searching for suitable water depth, substrate and water flow for the spawn mass.

The size of the spawn mass differs greatly from previous published accounts (field and laboratory), which have described between 500-1000 eggs (NPWS 1998). Factors such as disturbance (from observers) and daylight conditions may have had an unknown influence on this. However, only five observations (2 field & 3 laboratory) have been made previously (NPWS 1998). Measurement of the egg capsules using a standard ruler showed them to be 2-2.5 mm in diameter. Eggs were adhered to the gravel and detritus substrate. Depressions ranged in water depths between areas of moisture to a maximum depth of 4 cm. The main egg deposition site was 2 cm deep. The immediate microhabitat consisted of silt, gravel (1-3 mm diameter), and leaf litter. Interestingly, oviposition did not take place mid-stream as previously reported (see NPWS 1998) but in a side stream. A possible explanation for this was inappropriate oviposition sites mid stream (bedrock). The adjacent stream bank was covered in moss and suggested a reasonably permanent soak flowed into this section of stream, thus providing a permanent water source. Bordering the nest sites were permanent pools containing algae suitable for tadpoles.

The spawn was checked daily through close visual inspection for the next seven days. During this time no predation, disturbance, or hatching were observed. However, a visit to the site on the 1.3.99 some 14 days after spawning revealed many small tadpoles within the nest site. Tadpoles were observed to hide under leaf litter during the day but became more visible at night. Tadpole length ranged from 6-10 mm total length (average approx. 7-8 mm, n=20). When I last visited the site on the night of 2.3.99, some tadpoles had moved into adjoining areas (up to 20 cm from the nest site). It was apparent that a high hatching rate occurred with only a few egg capsules remaining unhatched. Interestingly, crayfish did not seem to disturb the nest site despite their common presence within this stream. No fish or eels have been observed in this stream to date.

Prior to the spawning observation, this site had been visited in excess of 40 times. Calling activity had commenced two days prior to this observation with vocal chorusing also noted at other sites two and three days prior. On the night of the 15 February large increases in individual counts were made on the transect at this site preluding to the breeding event. Males were observed in small groups (normally 2-3 individuals) and would often become territorial when calls were played from a small tape recorder. This had been observed previously at this site in September 1998 and may indicate that breeding had also occurred then. Male frogs were also noted grappling with one another near the amplexus site. Transect counts were also notably higher in September 1998. Further evidence of two breeding events per season was the small-medium tadpoles (30-45 mm total length, n = 15) found in the stream. Many streams within the study area often contain two cohorts of *M. balbus* tadpoles (pers obs). Previous published data on breeding *M. balbus* have recorded spawn masses/egg clutch sizes, deposition sites, however the data presented here is the first published account of an entire breeding event.

Of particular interest is the lack of female frogs observed during this event. Only three female frogs were located over an intensive five week study at the site. Given the cryptic nature of female frogs it is often difficult to provide accurate population assessments. However, it is known that female frogs will utilise adjacent habitats well away from breeding areas (Mahony *et al.* 1997; NPWS 1998; Lewis (b) in prep). Similar male:female

ratios (higher proportion of males) have been observed at other sites in northern NSW (Lewis (a) in prep). Studies should be directed at female *M. balbus* in order to assess their abundance, movements, and habitat use. Little is known on the ecology of female *M. balbus* and their greater mobility compared to that of male *M. balbus* potentially brings them into contact with deleterious factors on a more regular occurrence e.g. timber harvesting.

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POPULATION DENSITY AND HABITAT USE IN THE PENINSULA DRAGON LIZARD *(CTENOPHORUS FIONNI)*

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ABSTRACT

A short term mark-recapture study of Peninsula dragon lizards (*Ctenophorus fionni*) was conducted in February and March 1981. The one hectare study site was located in the Middleback Ranges, South Australia. The population was estimated to contain 27 adults and 44 lizards in total. The sex ratio among adult lizards was not significantly different from unity. Adult lizards were found more often on outcropping rock, whereas immature lizards were found more on scree between the outcrops.

INTRODUCTION

The Peninsula dragon (*Ctenophorus fionni*) is a medium-sized (<97mm SVL) rock-dwelling lizard which is endemic to Eyre Peninsula in South Australia. It is common in the Middleback Ranges on north-eastern Eyre Peninsula, where it occurs on jaspilite outcrops of the Middleback Range formation (Johnston 1982). These outcrops are dark in colour and the *C. fionni* which inhabit the Middleback Ranges are an isolated and unique melanotic population.

Morphological variation among populations of *C.fionni* has been described (Houston 1974). A characteristic hind leg pushup display is used in territorial disputes between males (Gibbons 1979). Warburg (1966) reported the rate of evaporative water loss in lizards which he identified as *C. fionni*. But these lizards were probably *C. tjantjalka*, a species that was not known at the time (Johnston 1992). There are no published data on the population ecology of this species.

This paper reports a short-term study aimed at (1) estimating the population density of *C. fionni* at a site in the Middleback Ranges, and (2) determining whether mature and immature *C. fionni* utilise different parts of their environment, as has been suggested for closely related species (Gibbons & Lillywhite 1981).

MATERIALS & METHODS

The study was conducted in a north-facing gully on the Iron Knight ridge in the South Middleback Ranges. A one hectare area (Australian Map Grid references 6 325 900-6 326 000 North; 696 450- 696 550 East) was searched systematically for active lizards on the 24th February and again on the 1st March 1981. Each search took approximately four hours between 1100h and 1500h. Both days were warm and sunny.

When lizards were found they were captured and toe-clipped for individual identification (Fenner 1979). Their sex was determined by applying gentle pressure to the base of the tail to determine whether hemipenes were present. Lizards were regarded as mature if their snout-vent length (SVL) was greater than 54mm, and immature if their SVL was less than 55mm (Johnston 1997). Each lizard was recorded as being on either rock or scree. Rock refers to >1m^2 patches of solid, outcropping rock. Scree refers to small patches (<1m^2) of outcropping rock or loose scree. All lizards were released at the same place they were captured within five minutes.

The number of lizards in the study area was estimated using the Lincoln-Peterson Index (Caughley 1977). Using this method the population size (N) can be estimated if one knows the number of individuals captured in an initial sample (n), the number of individuals captured in a second sample (m), and the number of individuals captured in the first sample that were recaptured in the second sample (c):

$$N = n.m/c$$

and the variance (s^2) of N can be calculated as:

$$s^2 = n.m(n-c)(m-c)/c^3$$

Fisher's exact probability statistic (Sokal & Rohlf 1981) was used to test for (1) differences from unity in the sex ratio of mature *C. fionni*, and (2) differences in the use of two kinds of habitat (rock and scree) between mature male, mature female and immature *C. fionni*.

RESULTS

On the 24th February sixteen *C. fionni* were captured marked and released. On 1st March eleven *C. fionni* were captured. Of these eleven, four were recaptures from the first census. These data yield an estimate of 44 lizards occurring on the study site. The 95 percent confidence interval associated with this estimate is 15.4-73.6 lizards. However, this estimate is likely to be inflated due to the presence of recently hatched juveniles. Ten adults were captured and marked on 24th February. Eight adults were captured on 1st March, and three of these were recaptures. These data give a population estimate of 28 adult lizards per hectare. The 95 percent confidence interval associated with this estimate for adult *C. fionni* is 7.2-47.4 lizards.

The total of 23 lizards captured consisted of eight immature lizards, eight mature females and seven mature males. The sex ratio among the mature lizards did not differ significantly from unity ($P > 0.05$). Mature lizards were found more on rock outcrop, whereas immature lizards were found more on scree ($P < 0.05$; Table 1). Mature males and females did not differ in their use of these two habitats ($P > 0.05$; Table 1).

DISCUSSION

The Lincoln-Peterson technique for estimating population size makes several assumptions. It assumes that there is no change in the population studied due to births, deaths, immigration or emigration. It also assumes that all individuals in the population are equally catchable and mix randomly in the time between the two censuses. The data presented here may not satisfy several of these assumptions.

The population studied was an arbitrary sample of a much more extensive population of *C. fionni*. As such, the possibility exists that animals moved into or out of the study site during the period between the two censuses. Some individuals may have died between the censuses also. To counteract these possibilities, the period between the two censuses was deliberately small (six days). This would minimise the likelihood that deaths or movements would confound the population estimate. Young *C. fionni* enter the population in the Middleback Ranges in January and early February (Johnston 1997). This study was conducted after the young of the year have entered the population. So births are unlikely to have occurred in the population during the study.

Immature Tawny dragons (*C. decresii*) and Red-barred dragons (*C. vadnappa*) are displaced from optimal habitat by mature lizards (Gibbons & Lillywhite 1981). It has also been suggested that this may happen in *C. fionni* in the Corunna Hills (White 1976). This suggestion is supported by the data presented here. Large outcrops of rock contain numerous deep crevices which provide microenvironments in which *C. fionni* may shelter from climatic extremes and predators. Smaller outcrops and scree slopes contain fewer, shallow crevices which provide less than optimal

shelter. Thus larger outcrops appear to be, better quality habitat than scree slopes or small outcrops. The tendency for mature *C. fionni* to inhabit larger outcropping rocks is clearly apparent in Table 1. Whether this differential habitat use occurs because of active exclusion of immature by mature lizards, or simply reflects the increased likelihood of survival of individuals living in higher quality habitats remains uncertain.

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TABLE 1

The incidence of mature male, mature female and immature Peninsula dragons (*Ctenophorus fionni*) in two habitats. The data represent 27 captures of 24 individual lizards. Repeated captures were spaced 6 days apart.

Habitat	mature female	mature male	immature
rock	9	7	3
Scree	2	0	6

AN AGGREGATION OF THE OENPELLI PYTHON (*MORELIA OENPELLIENSIS*)

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INTRODUCTION

The Oenpelli Python (*Morelia oenpelliensis*) is a large slender python found along the western edge of the Arnhem land escarpment. It appears to be arboreal, living in the trees and caves along the edge of the escarpment, where it feeds on birds and mammals (Gow, 1977; Begg and Martin, 1980; Wilson & Knowles, 1988; Shine & Slip, 1990). Due to its secretive nature and relatively isolated habitat, very little is known of this snake. This article details an observation of aggregational behaviour of *M. oenpelliensis*.

OBSERVATION

A tour guide working in Kakadu National Park found three large *M. oenpelliensis* coiled together in a rock crevice at about 1000 hours on 8 July 1991. Unfortunately, he did not measure or sex the animals, although the snakes were handled and photographed. When the author later visited the site the snakes were gone. However on the basis of the photographs, all three snakes were greater than 3m in length, similar in size to a mature female measured by Charles and Wilson (1985).

The snakes were similar in pattern and colouration, being light grey brown with a series of dark brown blotches dorsally and creamy white ventrally, typical of the nocturnal coloration of the species illustrated by Shine (1991).

The crevice was located almost at the edge of the escarpment and about 10m from a permanent flowing creek. The crevice was 0.4m wide and 1.0m deep and 0.9m high and had a southerly aspect. The crevice was quite bare and open having only a few small rocks in it; consequently it offered no real protection. The area in front of the crevice was bare sandstone with a few clumps of tussock type grasses growing in a crack in the rock.

The surrounding area of Barramundi Falls (13°21'S, 132°27'E) is made up of a complex of diverse habitats (lowland forest, monsoon forest, sandstone plateau, cliff faces) which are typical of the Kambolgie sandstone escarpment area and offer a number of shelter sites for large snakes. Most recorded observations of *M. oenpelliensis* have been along the cliffs and in the caves of the escarpment.

DISCUSSION

Aggregations have been recorded in a number of Australian snake genera, including *Ramphotyphlops, Boiga, Dendrelaphis, Demansia, Hemiaspis, Pseudonaja, Rhinoplocephalus* and *Suta* (Hoser, 1980; Kinghorn,1956; Covacevich and Limpus,1973; McPhee,1959). Among Australian pythons, aggregations have previously been recorded for *Morelia spilota spilota* and *Morelia spilota variegata* (Hoser, 1980; Webber, 1978; Covacevich and Limpus, 1973). The present observation of aggregational behaviour appears to be the first for *M. oenpelliensis*.

Many of the aggregations reported for typhlopids, colubrids and elapids are associated with the cooler months of the year and may be related to the scarcity of suitable overwintering sites. However some aggregations of diamond pythons, *Morelia s. spilota*, have been demonstrated to be mating aggregations, with several males associated with a female for periods up to 8 weeks during the breeding season (Slip and Shine,1988).

Egg laying in *M. oenpelliensis* has only been recorded a few times. An adult female collected by the Northern Territory Conservation Commission on 29 September 1984,

produced a single egg on 20 October. A caesarean operation was performed on 27 October and nine fully developed eggs were removed (Charles & Wilson 1985).

Krauss (1992) has maintained *M. oenpelliensis* in captivity for many years, breeding them on two occasions. He observed copulation taking place in early to mid July and egg laying on 4 November 1986 and 6 November 1988 with an incubation period of 100 days.

The July aggregation reported here, if due to mating, is consistent with these few reproduction data for *M. oenpelliensis*. Alternatives, such as overwintering, or basking aggregation, normally associated with limited shelter sites, are considered unlikely due to the warmer climate and availability of plentiful and more adequate shelter sites in the surrounding area.

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SOME AMBUSH PREDATION POSTURES OF THE SCRUB PYTHON *MORELIA AMETHISTINA* (SERPENTES: PYTHONIDAE) IN NORTH EAST QUEENSLAND.

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INTRODUCTION

Morelia amethistina is Australia's largest snake and appears to form high population densities in suitable habitat (authors obs) In spite of this, detailed ecological data is limited (Calvert, 1996), with most data originating from captive specimens (Barker & Barker, 1994) and dissection of small numbers of museum specimens (Shine & Slip, 1990).

Morelia amethistina preys on a wide range of vertebrates including reptiles (Whitaker *et al*, 1982., Parker, 1982., Calvert, 1996), birds (Low, 1989., Calvert, 1996) and mammals (Shine, 1991., Calvert, 1996).

Little data exists for prey detection and capture behaviours of *M. amethistina*, with Shine (1991) suggesting that ambush predation strategies employed by *Morelia spilota* (carpet/diamond pythons) could also be cautiously applied to *M. amethistina*. Four ambush predation strategies of *M. amethistina* are recorded in the literature. Type 1; Martin (1995) reports that a juvenile tree kangaroo *Dendrolagus bennettianus* was captured by an adult *M. amethistina* lying in ambush at the base of a species of food tree favoured by the *Dendrolagus bennettianus* . Type 2; Low (1989) records the capture of a northern quoll *Dasyurus hallucatus* by an adult *M. amethistina* lying in ambush along a low branch on a large shrub. By lying with its anterior body broadly looped and angled towards the substrate, the python had enough reach to strike animals on the ground. Type 3; Low (1989) also observed adult *M. amethistina* lying on road verges with their necks broadly looped and heads facing the road, which he suggests was an ambush strategy for capturing mammals frequenting the road verge. Type 4; Calvert (1996) records an adult *M. amethistina* hanging on a tree branch by its tail over a path. The head and neck were coiled back in a strike position and the snake would remain in this position for several hours a time.

In this work the authors provide corroborative data and photographic evidence for ambush strategies, types 3 and 4, described above as well as an additional strategy (type 5) that we have dubbed 'periscoping' behaviour.

FIELD OBSERVATIONS

Between December 1998 and May 1999 ecological data was collected from 80 *M. amethistina* collected while crossing roads or engaged in apparent ambush predation behaviour on road verges. The majority of snakes were collected nocturnally off Jarra Creek/Cardstone Road, Tully (39) and the Lake Morris Road, Cairns (19).

The Jarra Creek/Cardstone Road begins on the outskirts of Tully and extends 50 km, terminating at the Kareeya Power Station (elevation 200m). The road bisects a mosaic of remnant rainforest patches interspersed with sugar cane, banana plantations and grazing land. The terminal 12 km of this road bisects relatively continuous rainforest and woodland habitats. Specimens of *M. amethistina* are encountered along the length of the road (even in areas where it is bordered on both sides by grazing land) but are more commonly encountered in rainforest habitats.

The Lake Morris Road commences at the foot of the Lamb Range, Cairns and climbs steeply for 15 km, terminating at Lake Morris (elevation 400m). This road bisects rainforest and

mixed forest habitats for its entire length, with specimens of *M. amethistina* being encountered along the length of the road.

Both roads have small, discrete patches of grassy road verge on the edge of rainforest. The terminal 4 km of the Jarra Creek/Cardstone Road has a more or less continuous grassy verge on the right hand side, bordering the steep banks of the Tully River Gorge. It is this section of road where the majority of *M. amethistina* exhibiting type 3 ambush predation, and all the specimens exhibiting type 5 ambush behaviour were encountered.

Council road gangs periodically slash these verges, resulting in regrowth appearing to attract a range of small to medium mammals, particularly red legged pademelons *Thylogale stigmatica*.

Both roads are non through roads and have little if any nocturnal vehicular traffic, so pythons and their prospective prey are largely undisturbed.

Adult *M. amethistina* apparently engaged in type 3 ambush behaviour were observed in these grassy verges on both roads. All snakes were motionless when observed with head and necks looped on the edge of the road, with the rest of the body concealed in grass or with most of the body exposed on the edge of the road in a series of broad loops (Fig. 1). In all the latter examples the tail and/or posterior body was anchored around grass clumps. Snakes engaged in this behaviour incorporated both sexes and ranged in size from 1430 to 3230mm SVL (snout to vent length) and 1000 to 6300 g in weight.

Four snakes were observed exhibiting type 5 periscoping behaviour (Fig. 2) on the Jarra Creek/Cardstone Road. All four snakes were motionless when observed and were lying in tight coils (1 snake) or loose coils (3 snakes) with their fore bodies raised vertically as high as 600mm from the substrate. All four snakes were within the grassy verges and all but one (Fig. 3), would have been invisible from a vehicle if lying with the entire ventral surface on the substrate. Table 1 summarises data collected from these individuals.

Figure 3 displays type 4 ambush behaviour described by Calvert (1996). This snake was photographed in a shed at the Hartley's Creek Crocodile Farm, Cairns where it spent several hours at a time poised over cages containing laboratory rats. This snake was periodically observed engaged in this behaviour over several weeks (G. Huddleston pers. comm.).

DISCUSSION

The authors believe that the body postures shown in Figures 1-3 represent ambush predation for the following reasons;

(1) These behaviours were only recorded in grassy road verges.

(2) Snakes encountered in other habitats, particularly when both sides of the road were bordered by forest, were actively moving when initially sighted and appeared to be simply crossing roads.

(3) All snakes involved in types 3 and 5 behaviour were motionless when initially

TABLE 1. Data collected from *M. amethistina* exhibiting type 5 ambush behaviour.

DATE	TIME	SEX	SVL (mm)	WEIGHT (g)
29/12/98	21.25	M	2720	3600
29/12/98	21.35	M	2880	3600
10/2/99	21.35	f	1560	506
24/2/99	23.01	f	2190	1700

sighted and did not attempt to move away until interfered with.

(4) Red legged pademelons *Thylogale stigmatica* were commonly observed feeding on the same grassy verges. Specimens of *T. stigmatica* were observed feeding in close proximity to all snakes engaged in type 5 behaviour.

(5) *T. stigmatica* can be comfortably ingested by adult *M. amethistina* and are a known prey species for this snake (Kend, 1997., Jensz, pers. comm.).

Discrete patches of grass that attract and concentrate suitable prey are possibly regularly patrolled by hungry *M. amethistina*. The type 5 periscoping behaviour appears logical when snakes are in grass, because; (1) It may allow the snake to perceive the prey presence (visually, chemoreceptively and via heat sensing pits) early enough to orientate the head towards the prey. Reaction to prey would be greatly reduced if the anterior of the snake was flush with the substrate among grass. (2) The prey may blunder directly into the snake, perhaps perceiving it as a branch or stick. Greer (1997) describes similar periscopirig behaviour for the black headed python *Aspidites melanocephalus*.

Snakes engaged in type 3 behaviour could launch an effective strike on the flat, open road surface.

The type 2 ambush behaviour described by Low (1989) appears to be a common strategy of *Morelia* spp. (Barker & Barker, 1994) and is particularly well documented for *M. spilota* (Slip & Shine, 1988., Fearn, 1995., Greer, 1997), so it is not suprising that *M. amethistina* should also display such behaviour. Jungle carpet pythons *M. spilota* (*M. s. cheynei* to some authors) may also ambush prey in grassy road verges. Two *M. spilota* were discovered exhibiting type 3 behaviour and a third specimen was discovered on the Lake Morris Road disappearing into road verge grass with an obvious mid-body bulge. Palpation revealed a 60g *Rattus* sp. so recently ingested that only the tips of the hair were wet with saliva. The rest of the pelt was completely dry.

Type 4 tail hanging ambush behaviour appears to be widely practiced among boas and pythons. Capture of bats by hanging for long periods in front of cave mouths is commonly practiced by New World boas in the genus *Epicrates* (Hardy, 1957., Rodriguez & Reagan, 1984., Prior & Gibson, 1997). Gasc (1997a, b) describes tail hanging ambush behaviour for the boas *Corallus enydris* and *Boa constrictor*. Similar behaviour has been recorded for Australian spotted pythons *Anteresia* spp. (Shine, 1991). Anecdotal records suggest type 4 behaviour is also practiced by the green anaconda *Eunectus murinus* (Fountain, 1904 in Murphy & Henderson, 1997), Indian python *Python molurus* (Wall, 1921 in Murphy & Henderson, 1997), African rock python *Python sebae* (Burdett, 1971 in Murphy & Henderson, 1997) and reticulated pythons *Python reticulata* (La Gironiere, 1853 in Murphy & Henderson, 1997). An anecdotal record (Ditmars, 1931 in Murphy & Henderson, 1997) suggests that green anacondas *E. murinus* may practice an aquatic version of type 5 periscoping behaviour with the neck reared and supported by the head floating on the water surface.

The data presented in this work suggests several interesting avenues of research into the predatory behaviour of *M. amethistina*. The authors recognise that without direct observations of the behaviours described resulting in successful capture and ingestion of prey, they cannot be definitely ascribed to ambush behaviour. Only detailed radiotelemetric field studies and/or maintaining wild caught adult *M. amethistina* in large outdoor enclosures will begin to quantify such behaviour.

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Fig 1. Type 3 Ambush behaviour with the body exposed.

Fig 2. Type 5 Ambush behaviour with the fore body exposed.

Fig 3. Type 4 Tail hanging ambush behaviour.

NEW RECORDS OF ASCARIDOID NEMATODES FROM THE GREEN PYTHON *MORELIA VIRIDIS* (SCHLEGEL, 1872) FROM PAPUA NEW GUINEA AND IRIAN JAYA

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A number of different parasites have been recorded from the green python *Morelia viridis* (Schlegel, 1872). These include the pentastomid *Armillifer arborealis* (Riley & Self, 1981) and a number of nematodes. Sprent (1973) described the ascaridoid nematode *Ophidascaris niuginiensis* from green pythons obtained from the Western Highlands and Markham River region of New Guinea. A further ascaridoid nematode, *Polydelphis anoura* Dujardin, 1845 has also been recorded from the green python (Sprent 1978). The spinicaudinid, *Moaciria chondropythonis*, was described by Gibbons (1979) from a captive green python at the Zoological Society of London, Regents Park. Wiesman & Greve (1982) identified *Strongyloides mirzai* Singh, 1954 from a captive green python in America. Further specimens of *Moaciria chondropythonis* have been reported by Jones (1983) from Port Moresby (the type locality of the species) along with one male and three female *Spinicauda sp.* He also recorded *Kalicephalus australiensis* from a green python of unknown provenance (Jones 1983). Walsh (1977) has also recorded a number of worm parasites from wild caught green pythons of unknown provenance.

One of us (BM) visited the Bernice P. Bishop Museum, Hawaii to extract liver tissue from preserved wild caught green pythons from New Guinea and Irian Jaya as part of a DNA research study being carried out by the Evolutionary Biology Department of the South Australian Museum. During dissection, two out of eight pythons examined were found to have nematodes in their intestinal tract. A total of nine nematodes were collected and taken for further identification. Collection data on the pythons comes from McDowell (1975).

Specimens examined

BPBM 3821 West Irian: Bokondini (3°35'S 138°30'E), 40 km north of Baliem Valley, Altitude 1400 m. Collected by L. & S. Quate - 18-30 November 1961. Female with rat in stomach. Two nematodes 1 complete male, 1 incomplete female with anterior and posterior ends missing. Neither worm in good condition.

BPBM 3450 Papua New Guinea: West Sepik District: Telefomin (5°10'S 141°35'E), Altitude 1600 m, rainforest. Collected by P. Temple - 1 August 1963. Seven nematodes: one complete male; three males with anterior ends missing; two females, posterior ends only and one immature specimen with tail missing. All were in fairly poor condition.

IDENTIFICATION

All nematodes are identified as *Ophidascaris niuginiensis* Sprent, 1973. In most respects, they conform to the morphology and measurements given by Sprent (which were based on 17 males and 10 females from four *Morelia viridis* from Papua New Guinea). The lengths of the two complete males from the Bernice P. Bishop Museum pythons range from 55-60 mm (compare with 62 mm for male holotype and 58-90 mm for male paratypes (Sprent 1973)). These specimens differ from the type material in having shorter spicules ranging from 1.50 - 3.50mm

(compare 4.0 mm for male holotype and 2.7-6.0 mm for male paratypes (Sprent 1973)). There is also an absence of vulval lips in one female in which that organ is present. We are not convinced that the large paracloacal papilla is in fact doubled as described by Sprent (1973). However these differences may be due to natural variation or more probably are artifactual, given the less than perfect condition of the nematodes recovered.

DISCUSSION

This is only the second record of the ascaridoid nematode *Ophidascaris niuginiensis* from green pythons. This nematode has also been recorded in *Liasis albertisi* also from New Guinea. The two new localities do extend its range. One of the pythons was collected from the Sandaun (West Sepik) Province, the other from the Baliem Valley of Irian Jaya. Both snakes were collected at high altitude and in rainforest, the preferred habitat of the green python.

Rodents are the intermediate hosts for infestation by ascaridoid nematodes (Sprent 1978) and it is interesting to note that one of the snakes examined (*BPBM 3821*) had a rat inside its body. An account of the growth and development of ascaridoid nematodes in Australian pythons has been given by Sprent (1970). Although experimental infection of mice has resulted in several mice dying from a haemorrhage of the mesenteric vessels (Sprent 1973), there is some disagreement as to the effect these nematode infestations have on adult snakes.

Sprent (1978) concluded that the ascaridoid *Polydelphis anoura* was not harmful to host snakes. This view was not shared by Fiennes (1959) who associated a nematode infestation with inanition, anaemia and abscess formation after the mucous membranes had been penetrated by adult worms. Kutzer & Grünberg (1965) also reported blockage of the pancreatic and bile ducts by the same worm. As the green python is a nocturnal, arboreal hunter (Gow 1989) it is likely that rodents form part of its diet and these nematode infestations are a result of that dietary intake.

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HERPETOLOGICAL NOTES

PAIRED OVERWINTERING IN STIMSONS' PYTHON: COINCIDENCE OR DELIBERATE?

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Simpsons Gap is situated 25km west of Alice Springs, in the Chewings ranges, which form part of the West MacDonnell ranges. This is the study site of arid zone pythons for field energetics. In April 1997, 9 Stimsons' pythons (*Antaresia stimsoni*) were implanted with small transmitters and released. An attempt was made to recover these animals in September 1997 at the end of winter. Only 3 transmitters could be detected and the animals subsequently located. Of these, one was found dead and exposed in open woodland approximately 300m from where it was released. It appeared to have been predated upon. Another animal was recovered inside a large king brown snake (*Pseudechis australis*) (Bedford *et al.* 1999). The third animal was located under a rock half way up a scree slope on the eastern face of Simpsons' Gap. The rock was approximately 50cm long by 40cm wide and about 10cm deep. It was firmly embedded in the slope with no visible means of entrance to the chamber in which the animal was found. From data collected on the movements of this animal after release we know it entered this area in April and had been stationary all winter. When the rock was lifted a large *A. stimsoni* was caught, but subsequent inspection revealed that it was an animal which did not have an implanted transmitter. The animal which did have the transmitter was found coiled next to where the new animal had been found. It was dead and very desiccated. The python with the implanted transmitter was a male, the one which was alive and recovered was a large female. With gentle palpation she was found to have large developing follicles. The window of opportunity for fertilization in pythons when the female is developing follicles is small being about 4-6 weeks (Ross and Marzec 1990). With her large follicles we guessed that she had not been mated and only a limited time for egg fertilization remained. This female was placed with a captive male and was observed mating within ten minutes. They remained in copulation for about a day and a half, after which she refused all advances and appeared to ovulate a few days later. Large abdominal swelling was evident during ovulation. Eggs were laid in October (Bedford, in prep.).

This observation indicates that the female *A. stimsoni* had overwintered with a male with the intention of mating in the spring. Unfortunately during the overwinter period he died. It is interesting that the female was still in the sealed chamber with a dead partner and had not emerged to find and mate with another male, which might involve a high risk of predation in early spring. King brown snakes appear to be very active early in the spring (M. Haywood pers. com., Peter Comber pers. obs.), this may be to reach the condition needed for them to breed, by taking advantage of early emergence after winter of small reptiles such as small pythons and varanids.

Stimsons' pythons have proven to be one of the most difficult of the python species to breed, and confirmed breeding records of captives from the same locality are almost non-existent (Fyfe, pers. com.). It may be that this species is either partner specific, site spe-

cific or both, and compatible pairs need to be confined together and winter cooled for a spring mating. Only when the female is gravid does the sealed chamber get opened.

This conclusion is only one interpretation of this single incident, however, we put it to paper now in the hope that some keeper with good husbandry skills can obtain a few pairs of these animals from a single locality and try to breed them using compatible pairs and overwinter cooling.

ACKNOWLEDGMENT.

Permits supplied by Parks and Wildlife Commission of the Northern Territory.

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AN OBSERVATION OF PREDATION ON AN ADULT TOADLET (*UPEROLEIA LAEVIGATA*) BY A DRAGONFLY NYMPH

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Dragonfly nymphs are well known as predators of tadpoles (e.g., Licht, 1974; Heyer et al., 1975; Caldwell et al., 1981; Azevedo-Ramos et al., 1992). However, they have not previously been recorded to catch adult frogs. I report here on an apparent instance of a dragonfly nymph preying upon an adult *Uperoleia laevigata*.

On the 13th of September 1986 I was listening and spotlighting for frogs at a permanent pool approximately 100 metres north of "Lake Engadine" in Royal National Park, south of Sydney (AMG 316500 6227200). Light rain had fallen during the day and the air temperature was approximately 18C at 7:00PM. A number of individuals of *Crinia signifera, Limnodynastes peronii, Litoria fallax, Uperoleia laevigata* as well as one *U. fusca* were calling at the site. Whilst walking around the edge of the water I noticed a pale shape several centimetres under the surface in amongst some sedges. A closer inspection found the shape to be the underside of an adult male *Uperoleia laevigata*. It also became clear that this frog was being held upside down by a large dragonfly nymph. The nymph was holding the frog by the body and had commenced consuming the frog, starting at the left shoulder.

Both the frog and the dragonfly nymph were captured in a net, at which time the nymph let go of the frog. The nymph was collected and proved to be of the species *Hemianax papuensis*. The frog was still alive and, in fact, had suffered only a minor injury so far with a small piece of flesh having been removed from the top of its left arm. The frog was approximately 3cm in length whereas the dragonfly nymph was 6-7cm in length and obviously more than capable of holding the frog regardless of its struggles to free itself. It would appear likely that the frog would eventually have been consumed.

The finding of a dragonfly nymph eating an adult frog is probably an unusual occurrence for two reasons. Firstly, most adult frogs would be too large for a nymph to successfully restrain as it struggled to break free. In this case a large nymph succeeded in holding a small frog. Secondly, adult frogs would rarely enter the water and so be in a position to be captured by a dragonfly nymph. Male *Uperoleia laevigata* call from the banks of the breeding site and not in the water (pers. obs). In this case, I presume that the male frog may have entered the water in order to reach a different position to await a mate or chance to call. Alternatively, this male may have been in amplexus with a female that had entered the water to lay eggs and was seen by the dragonfly nymph. In either case, predation on adult toadlets by dragonfly nymphs is probably a rare event.

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COLOUR CHANGE DURING MATING IN THE ARID ZONE FROG *LITORIA GILLENI.*

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The centralian tree frog (*Litoria gilleni*) was formally described by Spencer in 1896, however there has been some difference of opinion as to its taxonomic placement, being interpreted either as a distinct species (Cogger 1992; Barker, Grigg and Tyler 1995), or as a colour variant of the green tree frog (*Litoria caerulea*) (Tyler and Davies 1986; Tyler 1992).

In September 1997, while searching for central carpet pythons (*Morelia bredli*) I observed a number of *Litoria gilleni* calling from a pool in Simpson's Gap, in the West MacDonnell National Park. Of interest was the fact that the 'green' frogs calling were in fact brown in colour. Thirteen calling males were found, all from the water. Subsequently males were observed calling from dry land, all animals were brown in colour. Six pairs of *Litoria gilleni* were observed in amplexus (figure 1), with the difference between male and female quite striking. Males were brown and females were green. Males which were separated from the female or disturbed by my presence for any length of time turned green again. The process of colour change took between 3 - 8 minutes for four separate animals. It appears that calling and amplexus in males is associated with a change to brown. The actual mechanism involved in this change is unknown.

This observation was further strengthened by the fact that a number of calling male and amplexing pairs of *Litoria caerulea* were observed during the wet season (1997/98) in the Darwin Botanic Gardens and no animal appeared to change colour during mating.

ACKNOWLEDGMENT.

Thanks to Greg and Reg Fyfe for their hospitality.

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AN OBSERVATION OF PROBABLE PREDATION OF THE COMMON MIST FROG (*LITORIA RHEOCOLA*) BY A COMMON BROWN TREE SNAKE (*BOIGA IRREGULARIS*).

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The common brown tree snake (*Boiga irregularis*) is one of nine species of colubrid snake found in Australia. Like the other members of this family it has a diverse diet that is made up predominantly of birds, lizards and mammals although frogs are also present in the diet of smaller individuals (Shine, 1991). The following is an observation of predation by a common brown tree snake on a common mist frog (*Litoria rheocola*) an endangered species of stream dwelling, rainforest hylid found in north east Queensland.

At 23:30 on the 25th February 1999 I was surveying a small stream just north of Cedar Bay National Park between Cooktown and Cairns (15°46′52″ 145°17′31″) as part of a frog monitoring program being run by the Queensland Parks and Wildlife Service. Observed on the creek was a common brown tree snake hanging from a vine approximately one metre above the creek with a frog in its mouth. The snake was estimated to be one metre in length. One third of the frog's body was consumed and it was obvious that the animal was dead. A closer examination of the frog confirmed it was a common mist frog. Judging by the size of the frog it was probably a male. At the same time that this was occurring there were two other common mist frogs calling within 2 metres of the snake.

After approximately 15 minutes the snake dropped the frog into the stream, making no attempt to consume it further. Unfortunately the body of the frog was not recovered as it fell into fast flowing water. It is thought that the frog was discarded as a result of my disturbance.

Common brown tree snakes have been observed on single occasions at two other frog monitoring sites at Lacey Creek (17°51′ 11″ 146°03′45″) and Tully (17°46′25″ 145°38′41″) foraging in streamside vegetation in lowland rainforest (*pers.obs.*, K.D. McDonald *pers.comm*). Common mist frogs and Australian wood frog (*Rana daemeli*) were present at the former site, common mist frog, green-eyed tree frog (*Litoria genimaculata*), waterfall frog (*Litoria nannotis*) and Australian lacelid (*Nyctamystes dayi*) at the latter. Common brown tree snakes have also been documented predating a resting eastern water dragon (*Physignathus lesueurii*) on a stream in the Wet Tropics (Retallick and Hero, 1994).

On streams which pass through rainforest at lower altitudes in the Wet Tropics of Queensland, common mist frogs, along with Australian lacelids and green-eyed treefrogs are a prominent part of the nocturnal frog fauna (*pers. obs*). If common brown tree snakes are regularly foraging along rainforest streams, frogs, including a number of endangered species, may form an important part of their diet at these sites.

ACKNOWLEDGMENTS

I thank Keith McDonald and Amanda Freeman for their helpful comments. The frog monitoring project has been possible as a result of funding provided by the Federal Government through the Natural Heritage Trust.

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PREDATION OF A NORTHERN DTELLA (*GEHYRA AUSTRALIS*) BY A RING-TAILED GECKO (*CYRTODACTYLUS LOUISIANDENSIS*).

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Mr Rob Whiston of Gap Creek via Ayton North Queensland made the following observation.

At approx 10.30pm on 15 March 1999 a large (24cm total length) Ring-tailed gecko (*Cyrtodactylus louisiandensis*) was seen to leap off the lower section of a wall of Mr Whiston's dwelling and seize an adult (10cm total length) Northem Dtella (*Gehyra australis*) from the floor.

It had hold of the Dtella by the side of the head and neck and quickly returned to the wall, positioning itself head down to the floor. Any attempt by the Dtella to grip the wall surface with it's feet was countered by the Ring-tailed gecko arching its neck causing the Dtella to hang free. The Dtella's struggles weakened over time, but some 35 minutes elapsed before all sign of life ceased.

The Ring-tailed gecko then carried its victim to ceiling height and proceeded to push and manipulate the body of the Dtella against the ceiling panel as a means of assisting its consumption. The process of swallowing the Dtella took approx five minutes.

Mt Whiston's observations of this event prompted him to describe the catching and killing of the Dtella as 'well' practised', although this was the first time in 20 years he had observed a Ring-tailed gecko prey on another gecko species. He added that the Northern Dtella becomes incredibly abundant in and around his home at certain times of the year and he had frequently seen small Brown tree snakes (*Boiga irregularis*) and White lipped tree frogs (*Litoria infrafrenata*) preying on them.

Mr Whiston's residence is sited on the eastern bank of a permanent creek and is surrounded by well established gardens and remnant stands of complex mesophyll vine forest, Type 1A (J K Tracey 1982 *The Vegetation of the humid tropical region of North Queensland*)

ADDITIONAL CAPTIVE REPRODUCTION IN *PSEUDECHIS AUSTRALIS* (SERPENTES: ELAPIDAE) FROM WESTERN AUSTRALIA

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Bush (1995) recorded reproductive data on this species from the Pilbara region and compared it with Fitzgerald and Pollitt (1981) and Fyfe (1991) from eastern and central Australia respectively. Here, I present a record of captive reproduction from the wheatbelt region, south-western Western Australia. *Pseudechis australis* is a common snake in most of WA, but becomes scarce south of 32° latitude. Some recent records of this species from the southern extremity of its distribution in the Darling Range include Mount Dale (32° 08′ S 116° 18′ E), Christmas Tree Well (32° 13′ S 116° 25′ E) and Gooseberry Hill (31° 57′ S 116° 03′ E). Examination of the Western Australian Museum records for *Pseudechis australis* and the highly sucessful *Pseudonaja nuchalis* from the agriculturally developed wheatbelt region show that the former is less common (Chapman and Dell, 1985). This is confirmed by reports from local herpetologists who encounter *P. nuchalis* much more frequently than *Pseudechis australis*, especially around derelict structures and rubbish dumps. It appears the abundance of these two elapids is reversed in less disturbed pastoral areas like the Pilbara region (pers. obs).

The 1.1 metre female from Kelleberrin (31°38′ S 117°43′ E) was introduced to a 1.2 metre male from Watheroo (30°18′ S 116°03′E) at 11.40am on 8 November 1998. Copulation commenced almost immediately and continued until 4.30pm. When mating had ceased, the female was returned to her own box. The intensity of the union was so great that there was noticeable blood and presumably semen stains on cage floor. The presence of blood on a female's body or substrate serves as a reliable indicator to successful copulation (Ehmann and Swan, 1987) and (Bush, 1989). The weight of the female post-insemination was 1147gm. Directly after this mating the male was introduced to a 5yr captive bred female but showed no interest.

Based on my experience keeping *Pseudechis australis* I believe, when excited, it is the most vigorous tail thrasher of any elapid species maintained, irrespective of sex. Sometimes the tail is 'smacked' so hard against the side of the terrarium that it raises the possibilities of injuries. They appear impervious to pain.

On the 19 December, 41 days after mating, 7 healthy and 2 infertile eggs were laid. The seven eggs were immediately removed, weighed, measured (Table 1) and incubated in a 200g vermiculite/100g water mixture at 30oc. The total mass of fertile eggs was 224.4g and weight of female after egg deposition was 816gm. The estimated relative clutch mass if all nine eggs were fully developed is 0.35. All eggs (Table 1) hatched between 21-28 January 1999 after an incubation period of 64-71 days. Postnatal sloughs in this clutch occurred 34-39 days after hatching.

Table 1: Egg and hatchling data for *Pseudechis australis*

EGG	HATCHLING
A. 57 X 29mm. 31.6g.	295mmTL. 20.4g.
B. 59 X 27mm. 33.5g.	256mmTL. 12.3g.
C. 55 X 27mm. 30.8g.	298mmTL. 19.8g.
D. 58 X 23mm. 31.5g.	287mmTL. 19.2g.
E. 57 X 25mm. 28.0g.	220mmTL. 11.0g.
F. 62 X 25mm. 33.8g.	285mmTL. 20.0g.
G.68 X 27mm. 35.2g.	270mmTL. 16.4g.

ACKNOWLEDGEMENTS

I thank Brian Bush, Russell Brown and David Pattison for their records of this elapid from the Darling Range, with additional thanks to Brian for comments on this MS.

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Footnote: Following raids by CALM officers from the Wildlife 'Protection' Branch on the 7 January 1999 the adult pair reported on here were seized along with several other long term and captive bred snakes. The hatchlings were subsequently seized on 11 March. Having no licensing system in WA amateur herpetologists that are known to CALM are soft targets. This abuse of public tax monies does nothing for the environment and frustrates both amateur research and harmless enjoyment.

OBSERVED MATING OF PYGOPODID LIZARDS

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In the Lamington National Park in south-eastern Queensland recently, I had a chance encounter with a pair of mating pygopodid lizards. As I understand that no account of mating in any snake-lizard has yet been published, it is hoped that the following brief description of the event might be of interest.

During the hot early afternoon of 15 November 1999 a pair of what were initially thought to be small brown snakes were seen on a walking trail in open-forest country between Surprise Rock and Numinbah Lookout, on the Daves Creek walk in Lamington National Park. At a closer distance it was realised that the pair were snake-lizards in the act of mating. As they were intertwined it was difficult to determine their length, but around 700mm would be a close estimate. Both were unpatterned and of a uniform brown colour, with the female notably paler.

The pair were joined when first observed, with the male coiled around the female and holding her firmly with his mouth about 100-150mm behind her head, or roughly one-third of the distance from her head to vent. He also gripped her around her lower body with his two conspicuous flipper-like hind limb flaps. At least one of the pair (probably mainly the female as the male had his mouth full) made occasional clearly audible wheeze-like squeaks.

The engagement was observed from a distance of 1-2 metres for several minutes during which time the intertwined pair moved around on the trail continually, with the female apparently endeavouring to move in one direction and the male pulling her in the other. They eventually parted company abruptly and left the trail in opposite directions, disappearing into the dense grassy forest understorey.

Following later perusal of 'Reptiles and Amphibians of Australia' (Cogger, 1992) and 'Australia's Reptiles' (Wilson and Knowles, 1988), the snake-lizards are believed to be *Pygopus lepidopodus*. The location of this sighting is at grid reference 206781 on the Beechmont (Queensland) 1:25000 map sheet, and at an altitude of 800 metres.

BOOK REVIEW

Cogger, H.G. and Zweifel, R.G. 1998.

Encyclopedia of Reptiles & Amphibians.
UNSW Press, Kensington. 240pp.
R.R.P. $49.95

When I was a child, I was a voracious reader of every new book on herpetology that appeared on the bookdealers shelves (a habit that perseveres, to the detriment of my bank balance). The vast majority of more general herpetological books at the time were written and published overseas, and I was consistently disappointed by the poor representation of the Australian herpetofauna in these otherwise fascinating books. Not only was the information mostly on species not occurring in Australia, but when Australian examples were given, the information was often wrong (I've lost count of the number of such "Encyclopedias" that had misidentified photographs of Australian reptiles and amphibians). This always led me to wonder just how accurate the information was on species with which I wasn't familiar.

Now the balance has been restored. This magnificent encyclopedia is stuffed full of Australian examples, exquisite photographs, and colourful drawings, in a thorough coverage of the world's herpetofauna. Edited by well- known herpetologists, Hal Cogger and Richard Zweifel, it includes chapters written by a Who's Who of international herpetologists, including several who have spent time in Australia and New Zealand (Aaron Bauer, Carl Gans, Harold Heatwole, Bill Magnusson, Don Newman and Rick Shine).

On first opening it, the Encyclopedia delights the eye with the abundance of colour photographs and paintings. The latter, prepared by well-known wildlife artist David Kirschner, may initially lead the reader to think that the target audience is the younger reader. This impression is quickly dispelled when your eyes finally get to the text. This is a book for all ages and all levels of experience. Clearly written and very readable, even by the younger reader, everyone will find nuggets of information new to them.

The Encyclopedia is divided into three sections. The first section ("The World of Reptiles & Amphibians") contains chapters on classification, the fossil history of herpetofauna, habitats and adaptations, behaviour and endangered species. The following two sections cover the diversity of amphibians and reptiles, respectively, with individual chapters on each order (Squamata are treated at the traditional suborders, lizards (Lacertilia), snakes (Serpentes) and amphisbaenians (Amphisbaenia)).

The Encyclopedia first appeared in 1992, although it was little publicised and hard to find in Australia. A later edition, in 1994, which combined under one cover similar previously separate volumes on mammals, birds, reptiles and amphibians, also had a limited circulation in Australia. With this new edition produced by UNSW Press, the Encyclopedia of Reptiles and Amphibians is finally readily available to a local audience.

There are relatively few changes from the first edition. Five photographs and drawings have been replaced. Changes to the text are minor, and mostly involve taxonomic changes and biodiversity upgrades. The most significant upgrades are to the taxonomic chapters. Each begins with a marginal "Key Points" panel, which gives the number of species, genera and families in the order (or suborder) being discussed, the range of sizes, from smallest to largest species (both length and mass, with small outline drawings comparing size to humans or human parts), and a "Conservation Watch" section, which lists endangered species. The new edition lists the endangered species as given by the 1996 IUCN Red List of Threatened Animals, a list which differs markedly from the species categorised as threatened in the previous edition.

I found very few errors, although I may have overlooked some in my delight at locating yet more details unknown to me. The caption for the photograph on p. 20 has the typo *"Morelia spilotas"*, and the family name Hydrophiinae does not translate as "water-lover' (p. 201), but simply as "watersnake".

The pictures alone are worth the price of the book. The text is the icing on the cake, and makes this encyclopedia an essential purchase for anyone with herpetological interests.

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BOOK REVIEW

King, D. & Green, B. 1999.

Goannas. The Biology of Varanid Lizards. Second Edition.
Australian Natural History Series,
UNSW Press, Kensington. vi + 116pp
R.R.P. $29.95

The first edition of this book, which appeared in 1993, was the first of the current feast of books devoted to goannas (varanids or monitors to enthusiasts elsewhere in the world), and covered a number of topics which have been largely ignored by its more recent competitors. In addition to chapters on taxonomy and phylogeny, feeding, reproduction, general behaviour, and conservation and management, it also included several more physiological topics, with chapters on thermal biology, respiration, water use and energetics. It was also atypical in emphasising a single species, *Varanus rosenbergi*, a species which had been the topic of both authors' Ph.D. studies on Kangaroo Island in the 1970s, making it the most thoroughly studied Australian species until very recently. More recent volumes on varanids, which have generally been aimed at the herpetoculturist market, have devoted large sections to varanid biodiversity, presenting individual species accounts. Such sections were absent ftom "Goannas", which simply gave a table listing the recognised species, and then presented data in a more integrated, comparative manner. This made the book very readable (the data-rich text was "book-ended" with a short prologue and epilogue presenting a goanna's-eye view of life), yet with the information clearly aimed at the more scientifically-minded reader interested in comparative biology.

Although the first edition was reprinted in 1996 and 1997, the recent world-wide interest in varanids (partly stimulated by this book) has led to much additional knowledge of varanid ecology in the last decade.

While the text of this revised edition has not increased markedly in length (116 from 102pp.), there is a new chapter on parasites, the chapter on breeding now incorporates significant amounts of new data, and there are a few new colour plates. Other chapters have remained very similar to the first edition. The reference list includes some additions (about 25), bringing it up to date, at least to 1998, but has not attempted the sort of exhaustive compilation that was presented by Bennett (1998). One surprising exclusion was the lack of mention of the extensive series of papers by Grahame Thompson on the ecology of *Varanus gouldii* in the Perth metropolitan area, many of which are particularly relevant to the discussions of feeding, reproduction, home ranges and activity patterns. Conversely, while mention was made of recent gene-sequencing data published by Fuller *et al.* (1998), the phylogenetic conclusions of that paper, which were significantly different to previous chromosomal and microcomplement fixation phylogenies, did not carry through to the illustrations of Chapter 2, which still emphasise the earlier trees.

Those few errors I noticed were mostly carried over from the first edition. On p. 24, the term ileum was applied to the entire small intestine, and on p. 26, the illustration of the genital systems has the urodaeum of the cloaca in direct continuity with the vent, although the illustration on p. 73 correctly shows the proctodaeum interposed between the two. Although possibly not in error, the recognition of both *Varanus scalaris* and *V. similis* as Australian species distinct from *V. timorensis* (p. 15) remains unsubstantiated. These minor problems, however, in no way detract from the charm of the book, which provides a lucid introduction to the world of goannas, applicable both to the local and international reader.

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BOOK REVIEW

Heatwole, H. 1999.

Sea Snakes. Australian Natural History Series.
UNSW Press, Kensington. vi + 148pp.
R.R.P. $29.95

This volume is the sucessor to a book of the same title by the same author and publisher which appeared over a decade ago (Heatwole, 1987), although published in a different series (Australian Studies in Biological Sciences). The new version is more than just a new edition. Not only has it increased greatly in size (148 pp. vs 85 pp.), but also has changed format, with several areas repackaged in new chapters. The sections on ecology, previously a single chapter (Natural History), are now spread over four chapters (Natural History, Food and Feeding; Enemies; Population and Community Ecology) with much of the content of the last chapter new. Another addition to the text is a lengthy (17 page) chapter on distribution and biodiversity, reinforced by a short appendix listing the sea snake species and their distributions. These give a much better introduction to sea snakes for the non-specialist than the previous book. Other chapters cover physiological and morphological adaptations to life in salt water and to diving, while the final two chapters cover sea snake venoms and interactions between the snakes and humans, including both risk to humans, and commercial use of the snakes.

The paper is of better quality than the original, facilitating reproduction of black and white and line illustrations, which are much clearer (many are also new). There is also a new section of colour plates in the centre of the book with 29 illustrations over 12 pages. Most of these are good to excellent photographs of snakes intended to show the diversity of sea snakes, although some of the underwater photography is of lower quality.

By "sea snakes", Heatwole means all snakes that inhabit saline waters, and he includes some natricine, homalopsine and acrochordid snakes with the more traditional sea snakes, the hydrophiids and laticaudids. This has the advantage of allowing comparison between at least five independent invasions of the marine environment by snakes, with the opportunity to consider both parallel evolution in adaptations to this environment, and the diversity of solutions to the problems imposed by such a habitat.

While the book is clearly presented and very readable, it is likely to appeal mostly to students and biologists seeking an introduction to sea snakes, and here lies my major gripe with the book.

Although the reference list is much more useful than the previous book (9 pages and over 100 references, arranged by reference to chapter, vs a simple list of 17 publications and two television documentaries), and includes a number of recent references (over 30 since 1987, when the previous book appeared), it is still not comprehensive, with a number of studies alluded to in the text that do not appear in the reference list. To be fair, however, Heatwole does refer at the beginning of the Further Reading list to the extensive bibliography on sea snakes compiled by Culotta and Pickwell (1993). Further, Heatwole overlooks many lesser sources of information. For example, the table of litter/clutch size data (p. 33) does not include any information on one of the most common Australian hydrophiids, *Hydrophis elegans*, despite limited data being available for this species. In this respect, Greer (1998) provides a more thorough coverage.

In general, the book has few errors. Among the few that I detected were the discrepancy in numbers of hydrophiid and laticaudid species provided in chapter 2 (p. 6, 54 and 4) and listed in the appendix (56 and 5), and the statement that *Myron richardsoni* feeds on crabs (pp. 22, 52, unreferenced, but two captive animals I observed over a period of several months fed only on small fish and refused to consider crabs; see also Shine & Schwaner, 1985 and Shine, 1991).

REFERENCES

Culotta, W.A. & Pickwell, G.V. 1993. The venomous sea snakes: a comprehensive bibliography. Krieger Publishing Company, Malabar. 504pp.

Greer, A.E. 1998. Biology and Evolution of Australian Snakes. Surrey Beatty & Sons, Chipping Norton. 372 pp.

Heatwole, H. 1987. Sea Snakes. NSW University Press, Kensington. viii + 85pp.

Shine, R. 1991. Strangers in a strange land: ecology of the Australian colubrid snakes. Copeia 1991:120-131.

Shine, R. and Schwaner, T.D., 1985. Prey constriction by venomous snakes: a review, and new data on Australian species. Copeia 1985: 1067-1071.

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BOOK REVIEW

Cogger, Harold G. (2000)

Reptiles & Amphibians of Australia.
Reed New Holland,
Frenchs Forest. 808pp
R.R.P. $95.00

Cogger's latest Reptiles and Amphibians is basically a reprinting of the 1996 version with an updated and expanded Appendix. At 808 pages it is not substantially greater in overall page number than the 1986 version of 796 pages, the only difference being the addition to the Appendix of new species described or recognised since 1996, and a re-working of the selected reference list to include most of those publications in which those new species were described. In total approximately 39 new taxa are included in the revised Appendix but there are no illustrations of any of these, other than species already illustrated under a prior name (ie. the picture of the recently described freshwater turtle *Emydura worrelli* on page 199 formerly illustrated as *Emydura victoriae*). It also has a new cover.

For people with the 1996 reprinting the addition of 39 new names in the Appendix of the 2000 edition is not a great incentive to spending $95 to all but the most ardent of herpetological book collectors or researchers needing to reference this additional base line data. To people who do not yet have a recent treatment of the Australian herpetofauna this book represents remarkable valuable for money. The overall quality of book is excellent and the wealth of photographic illustrations unmatched. Only two publications have appeared in the past 10 years that presented a nation-wide treatise on the Australian reptile fauna, both of these are now well out date. State field guides are fragmentary in their coverage of the various reptile groups and vary as to how up-to-date they are. As a consequence Reptiles and Amphibians of Australia is the only one-stop choice for a comprehensive guide to this countries reptile and amphibian fauna.

However, the book is also getting to a size where functionality and cost may influence the direction of further editions, should there be any. Splitting it into two separate books, one on reptiles and the other on amphibians is one obvious option for the future, as is publishing future updates on CD's. I personally feel the publishers have done the author and the book a disservice by bringing the 2000 version out in anything short of a completely new edition, particularly given the book has served as the major guide for over 25 years. There will be criticisms of the book but the bottom line is that it will be the first reference taken off the shelf when something needs to be identified, or the distribution of a reptile or amphibian species checked, and it is likely to fulfil those role for a number of years to come.

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NOTES TO CONTRIBUTORS

Herpetofauna publishes articles on any aspect of reptiles and amphibians. Articles are invited from interested authors particularly non-professional herpetologists and keepers. Priority is given to articles reporting field work, observations in the field and captive husbandry and breeding.

All material must be original and must not have been published elsewhere.

PUBLICATION POLICY

Authors are responsible for the accuracy of the information presented in any submitted article. Current taxonomic combinations should be used unless the article is itself of a taxonomic nature proposing new combinations or describing new species.

Original illustrations will be returned to the author, if requested, after publication.

SUBMISSION OF MANUSCRIPT

Two copies of the article (including any illustrations) should be submitted. Typewrite or handwrite (neatly) your manuscript in double spacing with a 25mm free margin all round on A4 size paper. Number the pages. Number the illustrations as Figure 1 etc., Table 1 etc., or Map 1 etc., and include a caption with each one. Either underline or italicise scientific names. Use each scientific name in full the first time, (eg *Delma australis*), subsequently it can be shortened (*D. australis*). Include a common name for each species.

The metric system should be used for measurements.

Place the authors name and address under the title.

Latitude and longitude of any localities mentioned should be indicated.

Use the Concise Oxford Dictionary for spelling checks.

Photographs – black and white prints are preferred but colour slides are acceptable.

Use a recent issue of *Herpetofauna* as a style guide.

A computer disc may be submitted instead of hard copy but this should not be done until after the manuscript has been reviewed and the referees' comments incorporated. Computer discs must be HD 1.44 mb 3.5" in Word for Windows; Wordperfect; Macintosh or ASCI. Any disc must also be accompanied by hard copy.

Articles should not exceed 12 typed double spaced pages in length, including any illustrations.

REFERENCES

Any references made to other published material must be cited in the text, giving the author, year of publication and the page numbers if necessary. At the end of the article a full reference list should be given in alphabetical order. (See this journal).

Manuscripts will be reviewed by up to three referees and acceptance will be decided by an editorial committee. Minor changes suggested by the referees will be incorporated into the article and proofs sent to the senior author for approval.

Significant changes will require the article to be revised and a fresh manuscript submitted.

REPRINTS

The senior author will receive 25 reprints of the article free of charge.

Litoria gilleni amplexing. See paper on page 51.

Scrub python (*Morelia amethistina*) in ambush pose. See paper on page 39.